Sensor Collector QLI50

USER'S GUIDE

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VAISALA

DRAFT

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CHAPTER 1

GENERAL INFORMATION

About This Manual

This manual provides information for installing, operating, and maintaining the QLI50 Sensor Collector.

Contents of This Manual

This manual consists of the following chapters:

- Chapter 1, General Information, provides important safety, revision history, and warranty information for the product.
- Chapter 2, Product Overview, introduces the QLI50 Sensor Collector features, advantages, and the product nomenclature.
- Chapter 3, Installation, provides you with information that is intended to help you install this product.
- Chapter 4, Operation, contains information that is needed to operate this product.
- Chapter 5, Maintenance, provides information that is needed in basic maintenance of the product.
- Chapter 6, Troubleshooting, describes common problems, their probable causes and remedies, and contact information.
- Chapter 7, Technical Data, provides the technical data of the the QLI50 Sensor Collector.
- Appendix C,
- INDEX

Version Information

Table 1 Manual Revisions

Manual Code	Description
Draft without a code	This manual.

Related Manuals*

Table 2 Related Manuals

Manual Code	Manual Name

Safety

General Safety Considerations

Throughout the manual, important safety considerations are highlighted as follows:

WARNING	Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death.

CAUTION	Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.

NOTE	Note highlights important information on using the product.

Product Related Safety Precautions

The QLI50 Sensor Collector delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

WARNING	Ground the product, and verify outdoor installation grounding periodically to minimize shock hazard.

CAUTION	Do not modify the unit. Improper modification can damage the product or lead to malfunction.

ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench. When this is not possible, ground yourself to the equipment chassis before touching the boards. Ground yourself with a wrist strap and a resistive connection cord. When neither of the above is possible, touch a conductive part of the equipment chassis with your other hand before touching the boards.
- Always hold the boards by the edges and avoid touching the component contacts.

Regulatory Compliances

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License Agreement*

All rights to any software are held by Vaisala or third parties. The customer is allowed to use the software only to the extent that is provided by the applicable supply contract or Software License Agreement.

Warranty

For certain products Vaisala normally gives a limited one year warranty. Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or conditions of sale for details of the warranty for each product.

CHAPTER 2

PRODUCT OVERVIEW

This chapter introduces the QLI50 Sensor Collector features, advantages, and the product nomenclature.

Introduction to QLI50 Sensor Collector

The QLI50 Sensor Collector is measuring unit based on a microprocessor. The unit is designed for continuous operation in harsh environmental conditions. It acts as an interface between sensors and a data collecting computer.

The QLI50 can measure both analog and digital sensors. It stores data of one measurement at a time to its SRAM memory. The data is transmitted from the memory to the host processor by a separate command or automatically. Automatic sending can be either event based or based on preselected time intervals. The QLI50 also performs linearization of temperature sensors and error check-ups.

The QLI50 is connected to the host processor through one serial line channel. For a point-to-point connection at short distances the channel can be of the RS-232C type. For example, the connection between the maintenance terminal (computer) and the QLI50 is of this type. Another possibility is a galvanically isolated, RS-485 half-duplex connection. In this case, each QLI50 unit has its own address to which it responds.

The QLI50 Sensor Collector can be set to perform automatically simple measuring routines by sending it a certain ASCII command string. The QLI50 stores this setting to its internal non-volatile EEPROM memory. Several settings can be stored. The host processor can "teach" the QLI50 new measurement procedures at any time by transmitting its ID and thereafter, the new parameters.

The synchronization of the measurements can be carried out in a network as follows:

- The host processor sends a measuring command to all QLI50 units connected to the same RS-485 serial channel.
- The command makes each QLI50 start the measuring routine that it has learned last.
- After performing the measurement, the unit stores the results and saves them until collected by the host.

The QLI50 is a low current device that can be powered from the mains using a separate mains adapter or by solar panels. The total power consumption of the QLI50 is below 0.7 W without sensor supplies.

Product Nomenclature*

Table 3 Productcode Productname Nomenclature

Code	Common Name

CHAPTER 3
INSTALLATION*

This chapter provides you with information that is intended to help you install this product.

Minimum System Requirements*

The customer is required to purchase a suitable maintenance terminal, for example, an IBM PC or compatible with a keyboard. We recommend you to install the Termqli terminal program to the maintenance terminal. Other terminal programs can also be used for communicating with the QLI50. The settings needed are the following:

- 1200 baud, 7 data bits, even parity and one stop bit
- A 12 to 30 V, up to 1A DC power supply

The minimum system requirements for this product are listed in Table 4 below.

Table 4 Minimum System Requirements

Component	Minimum Requirement
IBM PC or compatible	500 MHz
Operating System	Windows NT 1)
Memory	640 MB RAM
Hard Disk	Optional
Drives	3½" diskette dirve for installing the program

1) With Service Pack 5

Equipment Requirements

The following equipment is required and supplied within the QLI50 package:

- One QLI50 unit with cable glands installed (PG 7) and six inlets shielded.
- Removable cable connectors for all inputs/outputs.
- Three serial channel selection modules: RS-232C, 2-wire RS-485, 4-wire RS-485. Three grounding jumpers.
- RS-232C/PC interconnection cable, 9-pin standard connector.
- User's Guide.
- PC compatible 1.44 MB diskette with Termqli program.

Table 5 QLI50 Package Contents and Part Types

Qty	Type	Name	Description
1	QLI501	QLI50	QLI50 board and plastic cover
1	QLY001	RS-232C adapter and RS-485 send	Serial communication module
1	QLY002	RS-485 2-W adapter and RS-232C send	Serial communication module
1	QLY003	RS-485 4-W adapter and RS-232C send	Serial communication module
3	(1690)	Grounding jumper	⊥ and case connection
1	QLZ001	RS cable (2 m)	For connecting the QLI50 and the maintenance terminal PC
1		Screwdriver	For attaching the PCB
1		Allen wrench	For closing the enclosure
1		QLI50 User's Guide	This manual
1		Termqli program	3.5" diskette with program files

Selecting Location*

Finding a suitable site for the QLI50 is important for getting representative ambient measurements. The site should correspond to the general area of interest.

The QLI50 is designed for unattended operation.

Where the mains power is unreliable or unavailable, there are a number of alternative power sources that can be used for the QLI50 primary power supply. However, the alternative supplies may not have the ability to provide sufficient capacity to power the QLI50, its sensors, and communication devices for the required period.

Communication distances, data quantity, transmission speed, and real-time data transfer requirements must be taken into consideration when selecting appropriate communication equipment.

In many locations the environment places further demands on the operation of the QLI50 system. Some typical locations are listed below.

Tropical Environment

Tropical environments with high levels of solar radiation, high temperatures, and high humidity are quite demanding on electronic equipment. High wind speeds associated with tropical storms also place restrictions on the types of masts and mounting accessories to be used in a system. Equipment enclosures must be designed to keep all equipment within their specified operating temperatures.

Marine Environment

Exposure of sensors and equipment to marine environments with high levels of salt will cause rapid corrosion of equipment unless adequate precautions are taken. We recommend a visual check once a year.

Low Temperature Environment

The cold experienced in the arctic areas, Antarctica, and at high altitudes will cause many materials to become brittle or lose their elasticity. Snow and ice accumulation may also prevent correct sensor operation and heating may be required to keep sensors and equipment within their specified operating temperatures.

Installation Procedure

QLI50 Indoor Installation

When the environment is an office or a technical room, the QLI50 is mounted directly to a wall or customer's cabinet. In extremely dusty or dirty environment remember to terminate the cables appropriately and to tighten the cable glands carefully.

QLI50 Outdoor Installation

When selecting the installation site, consider a shaded place which is protected from wind and dirt. The site should be close to sensors, if practical. (vague)

Figure 1 Large System Setup for Mast Installation (2-1)

A large system setup can include a transformer, circuit breaker, additional lightning protectors, etc. For mast installations the box shown in Figure 1 above is recommended. Consult Vaisala for BOX50S. The additional enclosure is not necessary if no add-on units are used.

Grounding and Lightning Protection

Vaisala provides transient protection devices, which can be ordered separately. In most cases they are not necessary, but if the device might be struck by lightning (directly or indirectly, e.g. tower installations), consult Vaisala for these add-on protection devices.

Grounding Principles

The QLI50 must always be grounded carefully.

The grounding can be done in two ways:

a. With a separate grounding cable to a ground plane that has been verified to be good. (...to provide adequate/required grounding?)

b. Through the protective ground connector of the mains cable to the system ground of the wall outlet.

Figure 2 Grounding the QLI50 through the Mounting Prong (2-2)

Vaisala recommends grounding via the mains cable only for units installed indoors.

The fixing screws make the grounding contact between the circuit board and the housing. Thus, make sure they are always properly tightened.

If the sensor and data communication cables extend outside the building, use a separate ground connection.

WARNING	If the grounding is made via the mains cable and the mains plug is removed, the QLI50 Frame may contain hazardous voltages.

WARNING	A sensor cable as short as 100 m can cause a surge voltage dangerous to life, if lightning occurs close by.

Figure 3 Mast Installation: Grounding Principle (2-3)

For installations on a mast, the QLI50 must be electrically isolated from the mast and grounded directly via a cable or conducting rods - not through the mast. A possible lightning strike to the terrain may cause the voltage potential of the mast to rise from ground plane by several kV, which can damage the sensors or the QLI50 or both.

The grounding cable must be drawn as straight as possible and it must be as short as possible. The quality of grounding is to be checked with a georesistance meter. The grounding resistance must be less than 10 Ω.

Exceptions to Grounding

No grounding is needed in the following three situations:

a. When minor measurements are made indoors with short sensor and data communication transfer cables. The QLI50 must be either battery-driven or provided with a protection shielded power supply.

b. In mobile stations, such as cars and boats. The QLI50 is battery-driven or has a low-voltage supply.

c. When measurements are made in field conditions with short cables without line voltage.

Installation Sequence

1. Make sure that the circuit board is properly fastened to the enclosure with the fixing screws (torque 0.5 Nm). Place the plastic cover on top of the circuit board if it is not already there. This cover helps you to keep the cables in order and protects the electronic components.

NOTE	The QLI50 board contains parts sensitive to damage by Electrostatic Discharge (ESD). Follow the ESD precautionary procedures when touching, removing, or inserting the QLI50 Board.

NOTE	When the QLI50 board is not within its enclosure, keep it in an ESD protective bag to ensure data storage in the memory chips and to protect it from damage by ESD.

2. Choose the serial transmission mode to be used and connect the corresponding configuration module (See Figure 48 on page 129).

   An RS-485 serial channel configuration module must be used, if baud rate higher than 4800 is required.

3. Connect the QLI50 power and communication cables. For details, see section Powering Up the QLI50 on page 27.
4. Run the operational tests. For details, see Operational Check on page 29.
5. Mount the QLI50 housing to the installation place.

6. Terminate the sensor cables to the cable glands (see Figure 4 on page 23 and Figure 5 on page 23).
7. Connect all sensors at the same time. Check the sensors one by one. Read the Operating Manuals of all the sensors and check the specifications especially for power consumption, supply voltage, and warm-up time.
8. Insert the sensor wires into the plug connectors and tighten the screws (torque 0.4 Nm).
9. Close the housing and tighten the screws. Check that the sealing and the cover set tightly.

Cabling Principles

Figure 4 Terminating a Shielded Cable (2-4)

For proper EMI behaviour, use shielded cables and terminate the shield to the body of the cable gland:

1. A shielded cable and a cable gland.
2. Screw off the cable gland nut and put it on the cable with the sealing inside. Cut off the exterior insulation layer.
3. Put on the washer with larger diameter.
4. Push the cable shield against the washer.
5. Cut off the cable shield.
6. Push the second washer against the cable shield to position the shield between the two washers.
7. Cut off the inner insulation layer.
8. Insert the wires through the cable gland and screw on the cable gland nut.
9. Check that there are no damages to the wires and that the nut is tightened (IP68 is achieved when the sealing swells out about 1.0 mm).

Figure 5 Layout Example for Sensor Cables (2-5)

Use the hooks of the plastic cover to keep the cables in their places. Do not guide the cables over the connectors.

Figure 6 Example of Noise Reduction for a Thermocouple (2-6)

Figure 6 above shows an example of a thermocouple measurement when a double-shielded cable is used. This is the preferred solution for reducing high ambient noise with low output voltage sensors (such as a thermocouple). The outer shield must be terminated directly to the cable gland of the QLI50, while the inner shield is fed from the E pin in GUARD mode. The inner shield now follows the common mode level.

Preparing Installation*

Unpacking Instructions*

Initial Settings*

Jumper Settings*

Mounting*

Alignment*

Verification*

Connections*

Powering*

Disassembly for Transportation*

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CHAPTER 4

OPERATION

This chapter contains information that is needed to operate this product.

Getting Started*

User Interface*

Figure 7 Picture of the User Interface

Operating Instructions*

Powering Up the QLI50

To power up the QLI50, do the following:

1. Connect the power supply to QLI50 pins 33 and 34 (See Figure 8 below). Make sure the power supply output voltage is more than 12 but less than 30 Volts.
2. Switch the power on.
3. Check that the green LED on the circuit board starts flashing on and off once a second.

4. Switch the power off.
5. Connect the terminal cable to a serial port of the PC and to pins 60, 61, and 62 on the QLI50 connector block.
6. Check that the correct serial channel configuration module (QLY001 for RS-232C communication) is attached. See Figure 8 on page 29.
7. Start a terminal program, fo example Termqli, and set the terminal mode to 1200 baud, 7 data bits, even parity and one stop bit.
8. Switch the power on.
9. The QLI50 will send the following message to the terminal:

   ```
   VAISALA QLI50
   ```

   If the text is not shown, press ENTER (↵) within five seconds after a new power on (reset). During those 5 seconds the QLI50 is waiting for the ↵ at 1200 baud and will set to 1200 baud for further commands when the ↵ is pressed. This is applicable when you do not know the baud rate or the baud rate in RS-485 is too high and you want to use RS-232C for maintenance. The QLI50 will respond as follows (when the baud rate is OK):

   ```
   id VAISALA QLI50
   ```

   where the *id* is the device ID character if it has been set.

   If you do not press ENTER during the first few seconds, the QLI50 resumes communications at the rate that has been saved on its EEPROM.
10. Give the `OPEN id` command and press the ↵ to enter the command mode:

    ```
    id OPENED FOR OPERATOR COMMANDS
    >
    ```

    You can now use the QLI50 command set. First make the QLI50 echo the input characters:

    ```
    >ECHO ON↵
    ECHO: ON
    ```

    By default the `ECHO` is off.
11. Run the operational tests described in section Operational Check on page29.

Figure 8 QLI Connector Block. RS-232C Communications Enabled and Power Connected (3-1)

NOTE	Do not give the ECHO ON command if you are using the two-wire RS-485 communication adapter. The 2-wire loop echoes the characters and puts the QLI50 into an "echo loop". This loop is terminated only by a reset, and the ECHO OFF command must be given using the RS-232 adapter or using the framed command (which is not echoed). The command is the following: `<SOH><ID><STX><ECHO OFF><ETX>` For details on the ASCII codes, see Table 33 on page 112.

Operational Check

Check the operation of the QLI50 before connecting any sensors to it. The check requires a VDU or a maintenance terminal PC, a terminal program, for example Termqli, and a 12 to 30 VDC power supply. If the typed characters are not visible on the screen, give the ECHO ON command. Check the operation with the STA (status), PAR (parameters), and HWT (hardware test) commands.

```
VAISALA QLI50

OPENED FOR OPERATOR COMMANDS
>

ECHO: ON
```

For details of the Termqli program, see Appendix B on page 135.

PAR Command

```
PARAMETERS
VAISALA QLI50 VERSION 0.992 1994-06-01
ID STRING:

VOLTAGE SCALES *1000
G0      0.8364     0.8364
G1      0.0763     0.0763
G2      0.0076     0.0076
G3      0.0008     0.0008
INTERNAL SHUNT   22.0
DAC SCALE 1   40.000
DAC SCALE 0   -0.300
REF HEAT: OFF
```

```
DIGITAL INPUT REF: UP
TEMPERATURE UNIT: CELSIUS
TRIGGER: OFF
CHAIN: OFF
BAUD RATE  1200
ECHO: ON
AUTO MESSAGE:
REPEAT
```

STA Command

```
STATUS

VAISALA QLI50 VERSION 0.992 1994-06-01
DEVICE TYPE: QLI50
DEVICE REV: D
SERIAL NUMBER: A1234567
CALIBRATION DATE:
ID STRING:
SUPPLY VOLTAGE   14.3 V
CURRENT  1.2183 mA
IN PT100   30.7
REF TEMPERATURE  28.4
G0 OFFSET     -0.1 COMMON       1
G1 OFFSET     -0.9 COMMON      -0
G2 OFFSET     -4.0 COMMON       1
G3 OFFSET    -37.5 COMMON       2
ROM CHECK 8E3C
```

HWT Command

NOTE Remove all sensor connections before the HWT test command. The HWT command will test the digital I/O, analog powers, and check some of the status values. The QLI50 waits about 10 seconds after test 25 for the reference heating test 26. See the HWT command description below for details.

```
   1   14.3   OK
   2 1.2183   OK
   3   30.7   OK
   4   28.4   OK
   5 0.8364   OK
   6      1   OK
   7     -1   OK
   8     -3   OK
   9    -39   OK
  10      0   OK
  11      2   OK
  12      0   OK
  13     -2   OK
  14      1   OK
```

```
  15      1   OK
  16   4.89   OK
  17   4.89   OK
  18  12.94   OK
  19  12.94   OK
  20  12.94   OK
  21  12.95   OK
  22  12.94   OK
  23  12.94   OK
  24  12.94   OK
  25  12.94   OK
  26   73.7   OK
  27      1   OK
  28      1   OK
```

CLOSE Command

```
LINE CLOSED
```

Operation

The QLI50 communicates with the user or the host computer via one serial line. In the QLI50 there are three communication modes:

- Automatic sending of messages
- Interactive (command) mode
- Polled mode

The interactive mode is started by the OPEN command (with device ID as parameter, if the ID is set) and the serial line is left to the polled or automatic message mode by the CLOSE-command. The polled or automatic mode is selected by the AMES and REP commands.

The commands are introduced in section

List of Commands on page 32 and described in detail in section Message Commands on page 64. The measurements are configured in a sequence that begins with the SEQ command (see section Sequence Definition (SEQ) on page 33) and includes channel type definitions and options (see section Measurement Configurations on page 37).

NOTE	A command consists of a command identifier and parameters. The command line is always terminated by pressing ENTER (↵). There must be one or more spaces between the command identifier and each parameter, if not otherwise mentioned. The <BS>-character (backspace) can be used in editing the input.The > character is the prompt of the QLI50. It is shown on the display screen when the QLI50 is ready to receive commands.

List of Commands

Command	Display Data Message Type
MES *sid*	Displays data message type 0
TMES *sid*	Displays data message type 1 (tab)
DMES *sid*	Displays data message type 2 (,)
AMES *number*	Sets automatic message type
AON *channel 0...9*	Excitation voltage ON
AOFF *channel 0...9*	Excitation voltage OFF
BAUD *rate*	300, 1200, 2400, 4800, 9600, 19200, 38400
CAL GN *value*	Analog input calibration
CALDAT *string*	Calibration date
CHAIN ON/OFF	System configuration
CLOSE	Releases the line for automatic messages
CLR *counter number...*	Clears digital counter(s)
DCAL	DAC output current calibration
DEVREV *string*	Device revision
DOUT *data mask*	Writes output latch
DTYPE *string*	Device type
ECHO ON/OFF	Disables input character echo (ECHO OFF used for 2-W RS-485)
HWT	Hardware test (disconnects sensors)
ID	Sets device identifier character (A-Z or 0-9)
IG *current in mA*	Writes DAC
INITEE	Erases EEPROM data
NEW	Removes measurement sequences
OPEN	Assigns the line for operator commands
PAR	Parameter message
PULL UP/DOWN	Digital I/O pull up/down
REP *sid time unit*	Repeats the defined sequence at the a defined interval
RESET	Restarts with watchdog
RHEAT ON/OFF	Voltage reference heating control
SAVE	Saves data structures to EEPROM
SEQ	Measurement sequence update
SERN *serial number*	Sets serial number
SHUNT *ohms*	Current measurement shunt

Command	Display Data Message Type
STA	Status message
TRIG ON/OFF 1/0	Measurement sequence control with digital input G7
TUNIT C/F	Temperature unit selection

Detailed descriptions and examples of these commands can be found in section Message Commands on page 64. Appendix A on page 131 includes some example configurations.

Sequence Definition (SEQ)

The measurement configuration is done with the SEQ-command. The general command format is the following:

```
SEQ sid channel (channel option, option,...) ... END
```

where

sid = Sequence identification (ID)

Three different sequences can be defined in the QLI50. The sequences are separated by the sequence ID, which is one alpha-numeric character, that is, 0 ... 9, A ... Z.

The channels can also be given in multiple lines.

```
SEQ sid channel(channel option, option,...) ...
*>... channel
*>... END
```

The *End* parameter must always be given at the end of the command. The extra prompt, *>, is given by the QLI50, when `<CR>` is typed before the *End* parameter.

The following is an example of the command:

```
>SEQ A TIN UIN  8EVE(PON)   END
```

where

>SEQ	=	Command ID
A	=	Sequenced ID
TIN	=	Internal PT-100 temperature
UIN	=	Power supply voltage

where

8EVE(PON)	=	Voltage measurement in channel 8 with excitation and power left on after measurement
END	=	End of sequence

To have the QLI50 start measurements, you also have to define a repetition interval. To display the results, define a message type (see section Procedure on page 34).

Procedure

Example 1:

Switch the power on and press ENTER within 5 seconds. The QLI50 responds with the following message:

```
1 VAISALA QLI50
```

NOTE	Here the ID of this QLI50 has been set to 1. The characters that will be typed by the user, will not be displayed on the screen.

NOTE	Press ENTER after all the following commands.

Type

```
OPEN 1
1 OPENED FOR OPERATOR COMMANDS
>
```

To remove the ID 1, type

```
ID -
ID STRING:
>
```

Now the ID string is empty.

Type

```
RESET
RESET COMMAND
VAISALA QLI50
```

Type

```
OPEN
OPENED FOR OPERATOR COMMANDS
>
```

Type

```
ECHO ON
ECHO: ON
>
```

From now on you can see the typed characters on the screen.

Define a measurement sequence by typing:

```
>SEQ A TIN UIN IR END
```

Start automatic measurements:

```
>REP A 10 S
REPEAT
A  10 S
```

Display the results by typing :

```
>MES A
TIN  31.97 degC, UIN 14.3 V, IR 1.21827 mA
TIN  31.95 degC, UIN 14.3 V, IR 1.21827 mA
TIN  31.95 degC, UIN 14.3 V, IR 1.21827 mA
TIN  31.92 degC, UIN 14.3 V, IR 1.21825 mA
Esc
```

ESC interrupts the performing of the measurement sequence and the prompt > is displayed again.

Different Ways to Display the Measurements

Select automatic message format by typing the following:

```
>AMES 0
AUTO MESSAGE:      0
```

The above indicates that message type 0 is selected.

The message is sent after the CLOSE command with the REP interval.

```
>CLOSE
LINE CLOSED
TIN  31.93 degC, UIN 14.3 V, IR 1.21824 mA
TIN  31.93 degC, UIN 14.3 V, IR 1.21824 mA
TIN  31.93 degC, UIN 14.3 V, IR 1.21824 mA
TIN  31.93 degC, UIN 14.3 V, IR 1.21824 mA
```

Give the OPEN command to stop displaying the message:

```
OPENED FOR OPERATOR COMMANDS
>TMES A
31.81     14.3      1.21823
31.79     14.3      1.21823
31.77     14.3      1.21825
>AMES 1
AUTO MESSAGE:      1
>CLOSE
LINE CLOSED
     31.91     14.3      1.21824
     31.91     14.3      1.21824
     31.92     14.3      1.21822
     31.92     14.3      1.21822
```

Type

```
OPEN
OPENED FOR OPERATOR COMMANDS
>DMES A
  31.83, 14.3, 1.21820
  31.83, 14.3, 1.21820
  31.81, 14.3, 1.21823
```

Data items are separated with ','.

```
>AMES 2
AUTO MESSAGE:      2
>CLOSE
LINE CLOSED
     31.84, 14.3, 1.21822
     31.84, 14.3, 1.21822
     31.83, 14.3, 1.21822
     31.83, 14.3, 1.21820
```

The SAVE command is used to store the measurement sequences to EEPROM. If this command is not given, the previous SAVEd sequence is used after the reset.

Type

```
OPEN
OPENED FOR OPERATOR COMMANDS

>SAVE
SEQUENCES TO EEPROM
>
```

Measurement Configurations

Three different measurement sequences can be configured in the QLI50. All analog measurements are executed consecutively in the sequence (there is one A/D converter and multiplexers). The digital measurements (except the AF and AFE channel types) are measured in parallel with the analog measurements and so use much less time in the sequence. The standard speed (see LS option) of the analog channel reading is about 10 samples/second. Other speeds can be set with the HS and AS options.

The measurement sequences are initiated by the time handler, when an automatic measurement loop is set up (REP command), or by the host computer command. A hardware trigger control can also be used (TRIG command).

Channel Types

The channel types are listed in the tables below.

Table 6 Resistance Measurement

Channel Type	Description
PT100	Pt-100 linearization, resistance, 1.2 mA excitation
PT100J	Pt-100JIS linearization, resistance, 1.2 mA excitation
RI	Differential voltage over resistor, 1.2 mA excitation

Table 7 Voltage Measurement

Channel Type	Description
V	Voltage
VE	Voltage with excitation

Table 8 Thermocouple Measurement

Channel Type	Description
TJ	Thermocouple type J
TK	Thermocouple type K

Channel Type	Description
TS	Thermocouple type S
TT	Thermocouple type T

Table 9 Current Measurement

Channel Type	Description
I	Current, external shunt

Table 10 Current Loop Measurement

Channel Type	Description
L	Current loop without power, C pin
LE	Current loop with power, C pin

Table 11 Pontentiometer Measurement

Channel Type	Description
RPI	Potentiometer (measured with current)
RPE	Pontentiometer (measured with voltage excitation)

Table 12 Bridge Measurement

Channel Type	Description
BGE	Bridge, voltage excitaton, 4 W
BR	Excitation voltage value
BGI	Bridge, current excitation, 4 W

Table 13 Frequency Measurement

Channel Type	Description
AF	Frequency measurement from analog input + channel, ref. 2.5 V
AFE	Frequency measurement from analog input + channel, ref. 2.5 V, with power
F1	Frequency 1, 10 kHz max.
F2	Frequency 2, 10 kHz max.
N1	Frequency 1 as counter 10 kHz max.
N2	Frequency 2 as counter 10 kHz max.

Table 14 Counter Measurement

Channel Type	Description
DN	Digital input low speed counter

Table 15 Digital Inputs

Channel Type	Description
GRAY	Max. 8-biy Gray code, default 6 bits (WAV15)
DS DBY	Digital state input bit, n = 0 ... 7, termination high Digital state input byte, with mask

Table 16 Switches in Analog Channels

Channel Type	Description
ASI	Analog channel state, with current excitation
ASE	Analog channel state, with voltage excitation, CF limit for 1
ASW	Analog channel switch read

Table 17 Internal Channels

Channel Type	Description
TIN	Thermocouple reference temperature (default), internal Pt-100
RT	Temperature of voltage reference
IR	Excitation current, 1.2 mA
UIN	Primary power voltage
IGEN	DAC current measurement and optional output update

Table 18 Dew Point Calculation

Channel Type	Description
TDEW	Dew point temperature calculation form X1 temperature and X2 humidity

Table 19 Text Channel

Channel Type	Description
TEXT	Additional text to data message

Table 20 Sequence Counter

Channel Type	Description
SCNT	Measurement loop counter for data control

Channel Options

One or more of the following options can be included in the channel definition:

Table 21 Options for Channel Definition

Option	Description
4 W	4-wire measurement
3 W	3-wire measurement
2 W	2-wire measurement
AS	nnnnn A/D converter speed
BV	Voltage bridge Vex channel identifier
CF	Channel factor
CR	New line in message
DLY	nnnnn delay in ms
FRM	mn message format m.n, if not default
G0	Fixed gain
G1	Fixed gain
G2	Fixed gain
G3	Fixed gain
GA	Automatic gain
GND	Measure against analog ground
GU	Guard to E-pin
HS	High speed A/D conversion
LR	Loop resistance in resistance measurements
LS	Low speed A/D conversion
MSK	nnn digital I/O mask
NL	No measuring
PON	Leave E-pin power as it is
RST	Reset counter when read
S0	Linear scale 0
S1	Linear scale 1
SINE	Sine wave frequency input, low level
T	Terminate differential input
TR	Temperature reference identifier, when not internal Pt-100
UN	n 0 ... 31
UT	Do not terminate differential input
V12	12 V power instead 15 V standard (5 V channels 8 and 9)
X1	Parameter
X2	Parameter
X3	Parameter
X4	Parameter
X5	Parameter
" "	"Text" max. 14 characters

Default Options

Default options for each channel type are presented in Table 22 below and default formatting in Table 23 on page 41.

Table 22 Default Options for Channel Type

Channel Type	Default Options
V	GA, LS, T, DLY 0
VE	GA, LS, V15, T, DLY 0

Channel Type	Default Options
I	GA, LS, T, DLY 0; channel type CI uses internal shunt (22 ohm)
L	GA, LS
LE	GA, LS, V15, DLY 0
RI	4W, GA, LS, T, DLY 0
RPI	GA, LS, V15, DLY 0
RPE	GA, LS, T
BGE	GA, BV, V15, T, DLY 0
BGI	GA, LS, T, DLY 0, CF 0.0 ref. R
TJ,TS,TT	GA, LS, T, 0
TK	GA, LS, T, DLY 0
PT100	4W, GA, LS, T, DLY 0, CF 100
PT100J	4W, GA, LS, T, DLY 0, CF 100
TDEW	
AF	DLY 1 = 10 ms
AFE	V15, DLY 1 = 10 ms
TIN	TR
RT	
IR	
UIN	
IGEN	no DAC output
F1	
F2	
N1	
N2	
GRAY	MSK 3FH
DN	DLY 4 ms
DS	DLY 4 ms
DBY	DLY 4 ms, MSK 255
ASI	LS
ASE	LS, V15
ASW	
SCNT	

Table 23 Default Formatting for Channel Type

Channel	Unit	Format
V	V	52H
VE	V	52H
I	A	43H
L	mA	43H
LE	mA	43H
RI	OHM	52H
RPI	%	52H
RPE	%	52H
BGE	ppm	61H
BGI	ppm	61H
TJ	degC	52H
TK	degC	52H
TS	degC	52H
TT	degC	52H
PT100	degC	52H

Channel	Unit	Format
PT100J	degC	52H
TDEW	degC	52H
AF	Hz	52H
AFE	Hz	52H
TIN	degC	52H
RT	degC	2H
IR	mA	25H
UIN	V	61H
IGEN	mA	34H
SCNT		40H
F1	Hz	52H
F2	Hz	52H
N1	pls	70H
N2	pls	70H
GRAY	deg	70H
DN	pls	70H
DS		70H
DBY		70H
ASI		70H
ASE		70H
ASW		70H

The units can be selected with the unit code numbers defined in the UN option. The format determines the resolution of the data values and is defined in the FRM option. See section Function of the Options on page 44.

Using Options

Possible channel options available for each channel type are presented in Table 24 below.

Table 24 Options Available for Channel Types

	4W 3W 2W	G1 G2 G3 GA	GU	S0 S1	TR	BV	LR	HS LS AS	PON V12	GN D T UT	DLY	MSK	SIN E	RST	CF	
V		*	*	*		*		*		*	*					
VE		*		*				*		*	*					
I		*	*	*				*		*	*					
L		*	*	*				*								
LE		*		*				*	*							
RI	*	*		*			*	*	*	*	*					
RPI		*		*			*	*	*		*					
RPE		*		*				*		*						
BGE		*		*		*			*	*	*					
BGI		*		*			*	*	*	*	*				*	CF: ref

	4W 3W 2W	G1 G2 G3 GA	GU	S0 S1	TR	BV	LR	HS LS AS	PON V12	GND TUT	DLY	MSK	SINE	RST	CF	
																R
TJ		*	*	*	*			*		*	*					
TK		*	*	*	*			*		*	*					
TS		*	*	*	*			*		*	*					
TT		*	*	*	*			*		*	*					
PT100	*	*		*	*		*	*	*	*	*				*	CF<0=offset, >0=Pt-100 scale
PT100J	*	*		*	*		*	*	*	*	*				*	CF<0=offset, >0=Pt-100 scale
TDEW				*												
AF				*							*					
AFE				*					*		*					
TIN				*	*											
RT																
IR																
UIN																
IGEN				*												Parameter Xn option for DAC output
F1				*									*			
F2				*									*			
N1				*									*	*		
N2				*									*	*		
GRAY				*								*				
DN				*										*		
DS				*							*					
DBY											*	*				
ASI				*				*	*							
ASE				*				*	*						*	CF: ON state voltage
ASW																
SCNT																

Function of the Options

4-, 3-, and 2-wire Measurement (4 W, 3 W, and 2 W)

The option 4 W is the default option for resistance measurement. Options 3 W and 2 W can be used, if best accuracy is not needed or the sensor does not have four wires. With the 3W option, QLI50 assumes all the tree wires similar, and compensates the wire resistance error by measuring the wire resistance (LR, loop resistance) and subtracting it from the measured sensor resistance.

If the channel factor (CF) is negative it is used as a measured value of the wire resistance and is added to the LR corrected resistance. Then both corrections can be used at the same time.

If the 2 W option is used, the wire resistance can be given in the channel factor option or, if a same length of wire is used in a 3 W or 4 W measurement adding the LR option in the 3 W or 4 W measurement. The latest LR loop resistance is subtracted twice from the 2 W measured value.

The loop resistance value is initialized to zero at the beginning of each sequence execution.

Nnnn A/D Converter Speed (AS)

Sets the A/D converter clock speed to a special value. For example:

- AS -112 sets 32914 Hz (3.6864 MHz / 32914 Hz = 112).
- AS -22 sets 167 kHz (3.6864 MHz / 167 kHz = 22).

For details on the behaviour of the ADC in a noisy environment and tuning of the notch filters, please contact Crystal Semiconductor Corporation. The ADC type is CS5501.

Voltage Bridge Vex Channel Identifier (BV)

When the bridge voltage is measured separately, that is, the BGE channel is used, the channel must have the BV used.

Channel Factor (CF)

The channel factor is a real number and has a meaning depending on the channel type.

New Line in Message (CR)

A new line can be added in message type 0 using this option. For example, type:

```
>SEQ A TIN(FRM31H,CR) UIN END
>MES A
TIN 31.5 degC
UIN 14.3 V
TIN 31.5 degC
UIN 14.3 V
```

Nnnnn Delay in Milliseconds (DLY)

The channel delay from the channel selection (with sensor power on) can be increased from the initial 5 ms by 10-ms increments using the DLY option. DLY 10 sets the delay to 100 ms. For digital counter and state channels, the DLY option sets the debounce time in 4-ms steps. The default debounce time is 12 ms.

Mn Message Format m.n, If Not Default (FRM)

Data values are presented in the default format (resolution), if the optional format is not used.

FRM 52H =>12345.67, that is, the width of the output field is m+n+1.

Fixed and Automatic Gain (G0, G1, G2, G3, and GA)

The automatic gain mode uses automatically the highest possible gain. If the current gain results to overflow in the A/D conversion, new measurements are automatically made with lower gain until the result is in range. Because of the possible discontinuity in the gain change (non-perfect calibration, drifts, etc.) or minimum time available, the gain can be fixed to a proper range (See section CAL on page 71).

The ranges are described in Table 25 below

Table 25 Gain Mode and Ranges

Gain Mode	Range
G0	-2.5 V ... 12 V
G1	-2.5 V ... 2.5 V
G2	-250 mV ... 250 mV
G3	-25 mV ... 25 mV

The auto gain function changes the amplifier gain higher (more amplification), when the input voltage is less than 0.03125 × range. The higher gain is used in the new measurement. If the input voltage is more than 0.375 × range, the QLI50 software changes the gain lower and immediately makes a new measurement.

Measure against Analog Ground (GND)

The C-pin voltage works as a reference for the single-ended measurements, if the GND option is not used. The QLI50 input amplifier Low input is connected to ground with an analog switch and the C-pin is disconnected from the amplifier input.

Guard to E-pin (GU)

The noise coupling to the input leads can in some cases be reduced by connecting the buffered input voltage to the sensor wire shield. The GU option makes this coupling to the E connector and it can be applied if the sensor is powered separately.

High Speed A/D Conversion (HS)

Sets the A/D converter clock speed to maximum (169 kHz).

Loop Resistance Update (LR)

If the 2-wire resistance sensor uses the same type and the same-length connecting wire as a 3- or 4-wire sensor, the loop resistance measured with that sensor can be used to correct the 2-wire sensor measurement. The default LR is 0.0. By setting the LR option in a 3 W or 4 W resistance measurement, the LR value is updated and that value is used in the 2 W measurements until LR is updated again in other sequence ends.

Low Speed A/D Conversion (LS)

Sets the A/D converter clock speed to optimum (33 kHz) for a 50/60 Hz reduction.

Nnn Digital Input Mask (MSK)

The digital byte I/O is selected using the MSK option. The mask selects bits from the eight digital inputs: G_7,G_6, G_5, G_4, G_3, G_2, G_1, and G_0. For example, four highest bits (binary 11110000) are selected from the input by

```
DBY(MSK 0F0H)
```

where

0 = Hexadecimal

where

0 = Prefix

The zero is used as a prefix so that the mask begins with a number. The measurement routine converts the output to area 0 ... 15 (0 ... F), that is, consecutive bits should be selected in the mask.

No Output (NL)

The data item with the NL option is not included in messages. Look at the example below:

```
>SEQ A TIN(NL) UIN END
>MES A

 UIN 14.3 V
 UIN 14.3 V
 UIN 14.3 V
>
```

Leave E-pin Power As Is(PON)

The sensor excitation can be left on with the PON option. Using this option is limited for current-excited resistance measurements as there is only one current source. If the input channel is changed, the current excitation is disconnected. For voltage excitation the total power consumption must be taken into account.

Reset Counter When Read (RST)

The counter value is cleared after every reading in the measurement sequence, if the RST option is used. The counters can also be cleared using the CLR command with the counter number(s) as a parameter.

LIenar Scale 0 and 1 (S0 and S1)

The "original" result in the engineering units is scaled with these factors. The detailed phase of using these parameters depends on the channel type. The default values are S1 = 1.000 and S0 = 0.000. (See section Example 1 in Appendix A on page 131 for defining the scaling factors).

Sine Wave Frequency Input, Low Level (SINE)

The frequency channels F1 and F2 can be used to measure low-level signals by using the SINE option, which connects an input amplifier to the signal.

Terminate Differential Input (T) and Do Not Terminate Differential Input (UT)

High impedance differential input may float the undesired level because of leakage currents. To eliminate this, the differential input (H/+) is terminated to ground by default with a 100-kΩ resistor. If this termination disturbs the sensor output, the UT option is used to disconnect the termination.

Temperature Ref. Identifier, When Not Internal Pt-100 (TR)

The thermocouple reference temperature measurement is identified with the TR option. The thermocouple measurements after this reference measurements use this temperature as reference. The internal temperature channel TIN does not need the TR option, but always updates the reference temperature, if the TIN channel is included in the sequence.

N 0 ... 31 (UN)

If the unit string used in message type 0 is not adequate, the UN option can be used to select a better string from Table 26 below.

Table 26 Unit Selection Options

n	Unit
0	
1	V
2	mV
3	A
4	mA
5	degC
6	degF
7	ohm
8	kohm
9	%
10	Hz
11	kHz
12	pls
13	hPa
14	psi
15	inHg
16	bar
17	ppm

n	Unit
18	deg
19	m/s
20	kt
21	km/h
22	rpm
23	mm
24	cm
25	m
26	in
27	W/m2
28	''
29	' '
30	' '
31	' '

For example:

```
>SEQ A UIN("SUPPLY VOLTAGE", UN 0) END
>REP A 3 S
>MES A
SUPPLY VOLTAGE 14.3
SUPPLY VOLTAGE 14.3
```

V 12 12 V Power Instead of 15 V Standard

The default excitation voltage is 15 V ±1 V. If the V12 option is used with the PON option the excitation voltage is left to 12V unless another PON is given. Normally the V12 option is valid for one measurement only. If the PON option is not used to leave power on, the previous voltage selection is restored in the power off phase of this channel measurement. For channels 8 and 9, excitation voltage is always 5 V.

If 12 Volts is needed continuously (PON) for one channel (sensor powering max. 12 Volts), use V12 for all other channels as well. If other channels have V15 PON, their voltage drops to 12 Volts during the V12 measurement.

X1 Parameter, X2 Parameter, X3 Parameter, X4 Parameter, and X5 Parameter

The auxiliary variables from X1 to X5 are used as input for special functions like the TDEW (dew point) calculation or IGEN output parameter.

" " "Text" Maximum of 30 Characters

The text option replaces the channel number and type. A total of 250 characters of text can be configured. This isapplicable in message type 0 (MES and AMES 0). For example:

```
>SEQ A TIN("QLI50 TEMPERATURE") UIN("SUPPLY VOLTAGE")
END
>MES A

QLI50 TEMPERATURE  31.49 degC,SUPPLY VOLTAGE 14.3 V
QLI50 TEMPERATURE  31.51 degC,SUPPLY VOLTAGE 14.3 V
QLI50 TEMPERATURE  31.49 degC,SUPPLY VOLTAGE 14.3 V
>
```

Error Codes

Message data is replaced by E0000nn, where nn is the error code, when the measured data is not valid.

Table 27 Error Codes

nn	Comment
1	Sensor Powering Error
2	A/D Converter Error, no analog data
3	Internal Hardware error
4	Connection Error (typically a loose connection)
5	Sensor Short Error (resistance measurements)
6	Sensor Break Error (resistance measurements)
8	Thermocouple Reference Error
9	Overflow Error
10	Underflow Error
11	EEPROM Error
12	No measurements done yet.

Basic Measurement Channels

Analog Measurements in General

The analog channels enable measurement of voltage, current, resistance and frequency. The analog inputs can be either differential or single ended. The H/+ and L/- terminals provide for the differential input, where the signal is the voltage between two wires. The following is an example of the configuration: 5 V for voltage measurement, wires connected to the H/+ and L/- terminals.

The single ended input produces a signal voltage between one wire with another wire at ground potential (usually the C terminal of each channel). The following is an example of the configuration: 5 + VE for voltage measurement with excitation voltage.

Some sensors need the excitation voltage or current (from the E terminal) for powering purposes. Note that all channels are powered by the common supply (see Figure 9 below). The default excitation voltage is 15 Volts but also 12 Volts can be selected with the V12 option. The excitation can be left continuously on with the PON option. See explanations of the options section Measurement Configurations on page 37and the detailed connector descriptions in section Connector Block on page 90.

Figure 9 Diagram of the Basic Analog Measurement (4-1)

Auto Calibration

The QLI50 updates the calibration of the A/D converter and the amplifier (A) offset every 32 seconds.

The A/D converter chip has its internal calibration scheme for zero and full scale. This is invoked by the QLI50 software.

The QLI50 hardware can internally connect the amplifier (A) input terminals together. For the auto-zero calibration, the input terminals are connected together and to ground for all four gains separately. The A/D converter bit value is then filtered by

New offset = 0.3 × new bit + 0.7 × old offset

(except for the first reading). The new offset value is before the amplifier gain values to convert the A/D converter data to volts.

The gain 1, 2 and 3 scales are constant by default, but they can be set using the CAL command. Gain 0 (-2.5 to 12 V range) voltage scale is calculated from the internal 2.5 V measurement (after restart only), if the scale is not set by using the CAL command.

Measuring within the Common Mode

The common mode input voltage is the maximum voltage that can be applied between the two inputs of a differential amplifier and ground without causing detriment. The voltage applied to the signal input includes not only the voltage produced by a sensor but also voltages from other sources: noise voltages induced into sensor cables, ground potential differences and DC offset voltages. No measurement errors occur if the total of all these voltages remain within the common mode range.

If the total voltage (including the signal and noise voltages) exceeds the QLI50 common mode range, errors will be generated in the readings. See section Specifications on page for the QLI50 common mode range.

To keep the input signal voltage within the common mode, ground loop voltages have to be duly managed (see Figure 10 on page 52). Ground loops are produced when two or more points that are nominally at ground potential are connected by a conducting path. These loops can generate unwanted noise signals and add offset to the input signal voltage that is received from the sensor.

Figure 10 Avoiding Ground Loops (4-2)

Resistance Measurement

The default resistance measurement expects the 4-wire configuration. In the 3-wire method the excitation wire resistance, to be called LOOP RESISTANCE (LR), is automatically compensated with the measured loop resistance.

The loop resistance is also measured in the 4 W mode if the LR option is used. The LR option in the 3 W and 4 W measurements also causes the loop resistance used in the 2 W measurements to be updated.

LR is an internal parameter of the QLI50, which is:

a. Set to 0.00 in the beginning of each measurement sequence
b. Updated with the actual resistance, if LR option is selected in 4 W or 3 W configuration.
c. The current value of the LR is automatically used for compensation in the 2 W configurations.

Figure 11 Resistance Measurement Connections (4-3)

Measuring ohms with reference current uses the following sequence:

1. Apply the measurement current, 1.2 mA.
2. If LR bit, then measure the L to C voltage and calculate corresponding resistance to get the LOOP RESISTANCE. Save the LOOP RESISTANCE for future use in 2-W or 3-W channels. The LR option is used for 4-W or 3-W wiring.
3. Measure the H to L voltage for sensor resistance ohms.
4. If the CHANNEL FACTOR is positive, multiply the ohms with the CHANNEL FACTOR. This scaling is used especially for the platinum resistor temperature sensors that have the 0°C resistance other than 100 Ω. For example, for Pt-1000 the CHANNEL FACTOR is 0.1.
5. If 3 W or 2 W, then subtract the LOOP RESISTANCE and add the negative CHANNEL FACTOR to the measured ohms. The negative CHANNEL FACTOR is the externally measured wire resistance, if LOOP RESISTANCE does not cover the whole wiring or it is not measured at all.
6. If 2 W, then subtract the LOOP RESISTANCE again for the second uncompensated wire.
7. Disconnect the measuring current, if not PON option.

Voltage Measurement

The default voltage measurement expects the differential input configuration. Single-ended input can be defined also to the +, - , and E terminals.

Figure 12 Voltage Measurements (4-4)

Channel type VE connects the excitation voltage on. With option V12 the common power is controlled to 12V mode. The PON option leaves the power on after the measurement. The power status is checked after the power connection. If the power fails, it is controlled off for about 255 seconds, then the power on switching is tried again.

In the differential measurement the L/- signal is terminated to ground (100 kΩ) by default. The UT option disconnects this termination.

The C pin connection can be replaced with the AGND (pin 21) and the GND option in the single-ended measurements.

NOTE	In the VE channel, the E terminal measurement measures the excitation voltage, which exceeds the allowed common mode range if the V12 option is not used.

Thermocouple Measurement

The J, K, S, and T type thermocouple sensors are supported by the QLI50 software. The QLI50 software always measures the cold junction temperature using the internal Pt-100 sensor (default) or an external sensor (TR channel option). This temperature is converted into volts using the conversion functions of the QLI50 software. The voltage corresponding to the reference temperature is then added to the voltage measured from the actual temperature sensor. The sum voltage is converted to temperature using conversion functions.

The temperature unit selection (Celsius/Fahrenheit) is automatically taken into account in the calculations. The sensor type is given in the channel type text.

Figure 13 Thermocouple Measurement (4-5)

The temperature ranges supported by the QLI50 are listed in Table 28 below.

Table 28 Temperature Ranges Supported by QLI50

Type	Range
J	-210 ... 1200 °C
K	-270 ... 1370 °C
S	0 ... 1370 °C
T	-270 ... 400 °C

If the calculation produces a temperature that is not within the range, an error code for Overflow or Underflow is reported.

The QLI50 checks the sensor break condition by applying the 1.2 mA reference current through the thermocouple sensor. If the current causes a voltage higher than 2.5 V, the Sensor break error code is reported.

Current Measurement

The default current measurement expects the differential input configuration and the shunt resistance (R) as the channel factor (CF) option. Single-ended input can be defined also to the +, - , C, and E terminals. CI channel uses the internal 22-Ω resistor.

Figure 14 Current Measurement Connections (4-6)

Current Loop Measurement

The current loop measurement is for 4 ... 20 mA transmitters. The current is measured using the internal 22-Ω shunt resistor between the C pin and the QLI50 analog ground.

The transmitter can optionally be powered from the excitation pin E (type LE).

Figure 15 Current Loop Measurement (4-7)

Potentiometer Measurement

Potentiometer can be measured with current (1.2 mA) or voltage (5, 12, 15 V) excitation. The voltage excitation is recommended only when the total resistance of the potentiometer is more than 10 kΩ. Then the current excitation voltage exceeds the QLI50 maximum.

Figure 16 Potentiometer Measurement (4-8)

Measuring ohms with reference current uses the following sequence:

1. Measure the voltage between H/+ and C terminals.
2. Measure the voltage between L/- and C terminals.
3. Calculate the percentage of voltage 2 over voltage 1.

Bridge Measurement

Bridge type sensor can be measured with current (1.2 mA) or voltage (15/12/5 V) excitation.

In the BGI configuration the QLI50 does the standard resistance measurement and then calculates the following:

Result = 1000000 × RESISTANCE / CF

CF is the sensor nominal resistance in ohms and the result is as ppm's.

In the BGE configuration the QLI50 does the standard voltage measurement and then calculates the following:

Result = 1000000 × VOLTS / BVolts

where

BVolts	=	The bridge excitation voltage measured with another channel with the BV option. The same excitation can be used for several bridges.

The 5 V supplies of pins 8 and 9 can output 30 mA each and the other 12 V pins 100 mA. The total powering current should not exceed 150 mA.

Figure 17 Bridge Measurements (4-9)

Frequency Measurement

The QLI50 has two types of frequency measurements. The primary frequency input channels are F1 and F2. All analog (H/+) channels can also be used as frequency inputs (AF and AFE channel types).

The F1 and F2 channels are similar in hardware. They include a preamplifier that can be activated with the SINE option in the configuration. With this option low level inputs can be measured.

In software the F1 and F2 channels cause an interrupt at every rising edge of the signal. The time between the interrupts is measured using the CPU on-chip timers. The maximum time between interrupts is set to about 10 seconds. If the time is longer, the frequency is reported to be zero. The minimum time between frequency calculations is about 60 ms. The interrupts during this minimum time base are counted for the frequency calculation.

The AF and AFE channel use the same type of time measurement but the default maximum waiting time is only 100 ms because the other measurements would otherwise be delayed too much. This limits the lowest frequency to about 100 Hz. The waiting time can be set longer with the DLY option.

The input shall be standard logic levels in the AF and AFE channels.

QLI50 Frequency Measurement Details

The QLI50 frequency channels F1 and F2 are measured using the CPU chip timers, counters and interrupt routines. The frequency calculation from the measured pulse count and time is done as a background routine independent from the measurement sequences. The measurement sequence part of the frequency channel only enables the frequency measurement system, reads the calculated frequency, and scales the result using the S1 and S0 scales.

The frequency is defined as pulses/time. The QLI50 basic time measurement clock is 14745600/12 = 1228800 Hz, that is, the time resolution is 1/1228800 = 0.813 µs. The accuracy of the QLI50 frequency measurement is basically dependent of the CPU chip crystal frequency accuracy and stability. In the highest frequencies also the 0.813 µs resolution in the time measurement causes some jitter.

Every rising edge in the F1 or F2 input causes an interrupt in the CPU chip. The interrupts are counted for the frequency calculation. Time is counted using an internal 16-bit counter. The counter overflows every 65536 pulse, that is, 53.33333 ms. This overflow is signaled to the pulse interrupt routine that stores the value of the time counter at the next interrupt. The pulse interrupt signals the background routine to calculate the unscaled frequency. If the next interrupt does not occur within about 10 seconds the background routine forces the frequency value to zero.

Frequency is counted from the pulse count and the time between events A and B. The pulse count is cleared and the 16-bit timer is saved as a base for the next time calculation. Time is calculated in the following way:

16-bit timer B - timer A + 65536 × timer overflows

For example, if 33 input frequency interrupts have been counted during 65777 timer ticks, that is, in time 65777 × 0.813 µs = 53.476 ms, the frequency is 33/53.476 kHz = 617 Hz. In the next calculation there might be 32 pulses in 63793 µs.

NOTE	The frequency measurement method used in the QLI50 F1 and F2 channels detects the signal ending quite slowly because it waits for the next signal edge. To reduce this problem, the QLI50 software calculates intermediate values when the time between interrupts is significantly longer than in the previous measurement. This calculation is done by having a guess of one pulse to be received and the using the time elapsed from the previous interrupt. This is done until the time is about 10 seconds, when the frequency value is put to zero. The advantage of the QLI50 frequency measurement method over the "counts per fixed time" method is a good measurement accuracy reached in a minimal time. The QLI50 time measurement resolution is about 0.8 microseconds

Counter Measurements

Frequency channels F1 and F2 are used as counters in channel types N1 and N2. The interrupts are counted and the signal level adjust is the same as in the frequency measurement.

The digital input pins can also be used as low speed counters, channels types nDN. The inputs are sampled 250 times/second. The input data queue is then analyzed by the software to utilize the counters. The minimum on-time of the signal can be set with the DLY option in 4 ms steps. The low to high edges are counted, if the signal is low for DLY time before the edge and high at least the same time after the edge.

The RST option causes the counter to be cleared after every read in the measurement sequence. The CLR command can be used by the host computer or the operator to clear any counter asynchronously.

In the nDN counters the CF parameter can be used as a turn over limit. CF 99 means that when the count would become 100 it becomes 0 instead.

Digital Inputs

The DBY, nDS, and GRAY types can be used to configure the digital input channels. Also the PULL ON/OFF command has an effect on the results.

The DBY channel type reads all the eight inputs, if the *MSK* parameter is given. For example, four highest bits (11110000) are selected from the input by (typing?)

DBY(MSK 0F0H)

The measurement routine converts the output to area 0 ... 15 (0 ... F). Therefore, consecutive bits should be selected in the mask. The hexadecimal mask must begin with a digit, hence the 0 in front of F0H (H stands for hexadecimal).

One bit can be read by the nDS channel type, where n is from 0 to 7.

In both DBY and nDS channel types the negative S1 scaling factor can be used to invert the result.

The GRAY channel type has a default mask 3F, that is, six (always lowest) bits are converted from the Gray-code to a binary value. Channel 6 power is also automatically (always) turned on during the reading. This default procedure is designed for the VAISALA WAV15 wind direction sensor, which also requires the *Pull down* parameter. Also other Gray-coded sensors can be measured using this channel type. Only the channel 6 powering may be different.

Switches in Analog Channels

The analog input channel is used for reading contacts with ASI measurement. There must be a resistor over the open contact to enable break detection. The short circuit fault can also be detected by two resistors.

Figure 18 Switches in Analog Channels (4-10)

The QLI50 measures the resistance between the E and C pins. The internal analog switch resistance (Rs) adds the result resistance by less than 100 Ω at 25 °C and about 200 Ω at 100 °C. The default parameters accept a total resistance of 700 Ω to 1400 Ω as 1 and less than 300 Ω as 0. The result polarity can be complemented by a negative S1 scale. The high limit for state 1 total resistance can be given as the CF parameter. The lowest total resistance accepted as 1 is half of the CF parameter.

In the optional configuration the high limit for R2 + Rs must be given as the S0 parameter. The lowest acceptable state 0 resistance is S0/2.

If the measured resistance is between the acceptable values, error 4 (connection error) is reported. The error number 6 (sensor break) is reported if the resistance is too high. Error 5 (sensor short) is used in the optional configuration if the resistance is less than S0/2.

Changeover switches can be measured using the ASW channel type. The most simple contact measurement is a special case of this type.

Figure 19 A Simple Contact Measurement (4-11)

The standard configuration gives legal values 1 and 2 and illegal values 0 and 3. The polarity can be changed by exchanging the + and - wires.

If the S1 parameter is negative the QLI50 expects the optional configuration and inverts the result from 0 to 1 or 1 to 0.

The actual measurement is done using the QLI50 1.2 mA current source.

Internal Channels

Internal Temperature (TIN)

The QLI50 internal temperature is measured with a Pt-100, which is mounted on the surface of the circuit board. The circuit board metal foils are designed to provide best possible thermal contact between the Pt-100 and the sensor connectors. This makes the TIN temperature a good reference for thermocouple sensors.

Initial accuracy of the TIN temperature is about ±0.3 °C. When the TIN channel is included in the same sequence with the thermocouples (before the thermocouple channels), it can be corrected using the S0 and S1 scaling factors and the TR option to get a more accurate reference for the thermocouples.

Excitation Current (IR)

Resistance measurements are done using a small stable excitation current and measuring the voltage it generates across the measured resistance. The excitation current is checked in the QLI50 auto-calibration sequence that is carried out twice a minute. The references for the current check are the voltage reference of the A/D converter and a very accurate and stable 100-Ω resistor included in the QLI50 electronics.

Voltage Reference Temperature (RT)

For maximum accuracy the voltage reference can be heated using the RHEAT command. This almost prevents the temperature drifting errors in voltage measurements. The IR channel can be used to monitor the temperature. This measurement is not accurate, especially when the reference chip is not actively heated (RHEAT ON), and is more an error check or it can be used in post processing.

Output Current (IGEN)

The QLI50 current output has a monitoring measurement for the actual output current. This value is measured in the IGEN channel type. The value is not calibrated but scaling factors S1 and S0 shall be used, if accurate values are required.

Optional use for the IGEN channel type is to convert an input value to current output. If option Xn (parameter X1, X2, X3, X4, or X5) is used in the IGEN configuration, the channel function takes the Xn data as input and then uses the S1 and S0 scales to scale the Xn value to milliamperes. The mA value is then scaled with DAC scaling factors to make the DAC data.

```
>SEQ A TIN(X1) IGEN(X1, S1 0.5, S0 5) END
```

The QLI50 internal temperature value is converted to 4 ... 20 mA current output. The scales S1 and S0 are used to set also the dynamic range of the output.

Primary Power Voltage (UIN)

The QLI50 can measure its primary voltage although it is galvanically isolated. The measurement is done through the transformer. The magnetic coupling inside the transformer and the loading of the power supply can cause error in the UIN value. The UIN voltage is for monitoring and checking the QLI50 system.

NOTE	When the QLI50 double power connectors are used for chained powering of the QLI50s, every link drops the power supply voltage for one diode threshold (0.7 V).

TDEW Calculation Channel

The TDEW channel type calculates dew point temperature from the input parameters X1 for temperature and X2 for relative humidity. Temperature unit (C/F) is automatically taken into account.

The following is an example:

```
>SEQ A 2PT100(X1) 4VE(PON,X2,S1 100,FRM  51H) TDEW END
```

The dew point is the temperature to which the air must be cooled at a constant pressure to produce saturation and deposit dew. The dew point temperature is calculated using the following formula:

$$TDEW = \frac{c \cdot b}{c \cdot \frac{a}{2} + b} - 273.16$$

where

a	=	$\ln\frac{100}{X2}$
b	=	15.0 a - 2.1 X1 + 2711.5
c	=	X1 + 273.16
X1	=	Measured air temperature (°C)
X2	=	Measured relative humidity (%)

TEXT Channel

Using the TEXT channel type:

```
>SEQ A TEXT("HEADING",CR) TIN UIN END
>REP A 3 S
>MES A
```

```
HEADING
 TIN  31.50 degC, UIN 14.3 V
HEADING
 TIN  31.52 degC, UIN 14.3 V
Esc
>TUNIT F

TEMPERATURE UNIT: FAHRENHEIT

>MES A

HEADING
 TIN  88.72 degF, UIN 14.3 V
HEADING
 TIN  88.75 degF, UIN 14.3 V
Esc
>TUNIT C

TEMPERATURE UNIT: CELSIUS

>MES A

HEADING
 TIN  31.49 degC, UIN 14.3 V
HEADING
 TIN  31.52 degC, UIN 14.3 V
Esc
>SEQ A TIN(UN 0, S0 273.15) TEXT("K") UIN END
>MES A

 TIN 304.69K, UIN 14.3 V
 TIN 304.67K, UIN 14.3 V
```

SCNT Channel

The SCNT channel starts a sequence counter as soon as the measurements are started. For automatic messages, the counting starts when the REP interval has been set.

An example is shown below:

```
>SEQ C TIN UIN SCNT END
>REP C 4 S
REPEAT
B   3 S, C   4 S

>MES C
 TIN  26.00 degC, UIN 14.6 V, SCNT    1
 TIN  26.01 degC, UIN 14.7 V, SCNT    2
 TIN  25.98 degC, UIN 14.7 V, SCNT    3
 TIN  26.03 degC, UIN 14.7 V, SCNT    4
 TIN  26.01 degC, UIN 14.7 V, SCNT    5
 TIN  26.00 degC, UIN 14.7 V, SCNT    6
```

Theory of Operation (??)

Software Description

The QLI50 software is designed to do specified measurements and communication, some data quality control, internal monitoring, and auto calibration of the analog input. The QLI50 does not perform any statistical calculations.

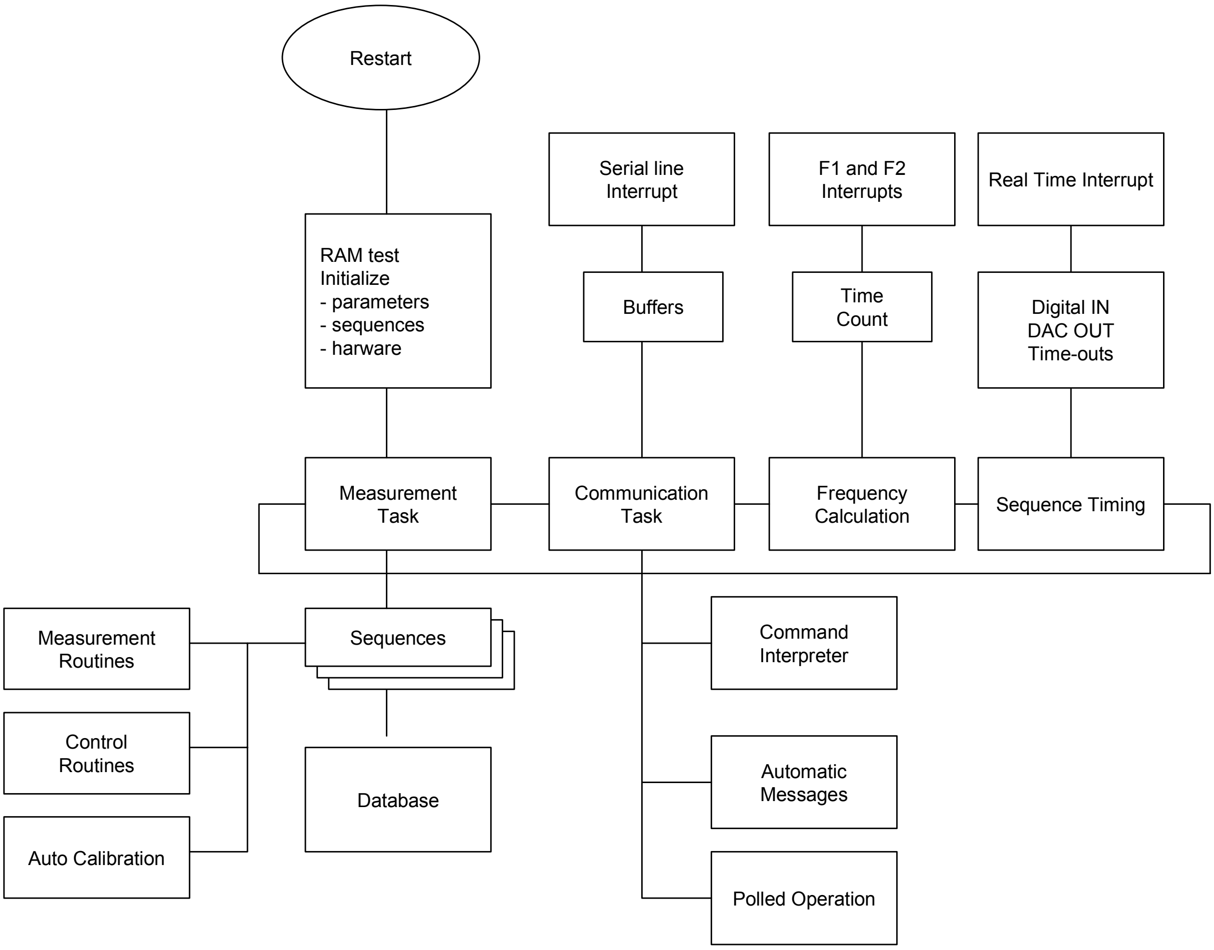

Figure 20 QLI Software Description

Message Commands

The message commands MES, TMES, and DMES, can be given in the interactive mode, after the OPEN command. See section QLI Communication on page 111 for operating modes.

The command formats are the following:

MES sid
TMES sid
DMES sid

The response is as follows:

- message format 0 for MES
- message format 1 for TMES
- message format 2 for DMES
- with REP *sid* repetition rate, until ESC is pressed.

An example is shown below:

```
>MES A
0DV    0.20 V,TIN   24.08 degC
0DV    0.20 V,TIN   24.08 degC

ESC
>TMES A
0.20    24.10
0.20    24.13

ESC
>DMES A
0.20,   24.08
0.20,   24.12
```

NOTE	The data value can be replaced by the error code occupying the same character field in the message as the normal data.

Example:

```
0DV    0.20 V,TIN   24.08 degC
0DV E000009 V,TIN   24.08 degC
```

where

E000009 = Error 9 (overflow error)

AMES Command

The AMES command starts measurements first after the CLOSE command (when the QLI operates in the automatic or polled mode).

The command format is the following:

AMES *message number*

The response is the following:

```
AUTO MESSAGE:      message number
>
```

The automatic message (AMES) is sent, when the sequence has the *REPeat* parameter set and the automatic message number is selected to 0 ... 4. The automatic message parameter also defines the polled message format.

Automatic message types 1 and 2 send the whole message as one line to simplify post processing. Message format 1 (tab) is directly readable into Microsoft Excel, for example.

Message Format 0

Message format 0 with the MES command is the following:

```
<channel number><channel pin><channel type><data value
or error code><data unit string><,>
```

A maximum of three (3) items are displayed in one line. Figure 21 below shows Message 0 formatting with the sequence options. The FRM and NL option affect also the other message types.

Examples:

```
>SEQ A TIN UIN END
>MES A


 TIN E00012 degC, UIN E012 V
```

Error code 12 replaces data as no *REPeat* parameter was set.

```
>REP
REPEAT
A

>REP A 0
REPEAT
A   0 S
```

Figure 21 Message 0 Format

REP 0 configures continuous operation (sequence is measured again as soon as the previous measurement has been completed):

```
>MES A

 TIN  31.53 degC, UIN 14.3 V
 TIN  31.52 degC, UIN 14.3 V
 TIN  31.52 degC, UIN 14.3 V
Esc
>
```

The message format for the AMES 0 command is the same as for MES and is started after the CLOSE command with the REP interval.

The text option can be used for replacing the default channel title. Options FRM, CR, UN, and NL can also be used for formatting the message. For examples, see section Function of the Options on page 44.

Message Format 1

Message format 1 with the TMES command is the following:

```
<data value or error code><tab><data value or error
code><cr><lf>
  0.20      24.10
  0.20      24.13
```

A maximum of six (6) items are displayed on same line in the command mode.

The AMES 1 command is the following:

```
<SOH><ID><SID><STX><TAB><data value or error code><TAB>
<ETX><CR><LF>
1A   31.92     14.3 1.21822
1A   31.92     14.3 1.21822
```

where

ID = The device ID, default 1 for the message.
SID = The sequence ID given in the SEQ command.

For the control characters, see section QLI Communication on page 111.

In the automatic message, all items are on one (long) line. If the device ID has not been set, `<SOH><ID><SID><STX>` is not displayed.

Message Format 2

Message format 2 with the DMES command is the following:

```
<data value or error code><,>
  0.20,   24.08
  0.20,   24.12
```

A maximum of eight (8) data items are displayed on same line in the command mode. In the automatic message, all items are on one (long) line.

With theAMES 2 command it is the following:

```
<SOH><ID><SID><STX><data>,<data><ETX><CR><LF>
1A  31.83, 14.3, 1.21822
1A  31.83, 14.3, 1.21820
```

If the device ID has not been set, <SOH><ID><SID><STX> is not displayed.

Message Format 3

Message format 3 is for VAISALA WAT11 simulation for the WAD21 wind display and other data messages for the DDP25 displays. The CHAIN ON command is required for the message, section CHAIN on page 72. After ten WAT message blocks there is one DDP25 block (one data item).

WAT11 part format is the following:

```
<esc><id><stx><id><sssdd>
```

where

sss = The wind speed multiplied by ten in meters per second, i.e., 023 is 2.3 m/s

dd = The wind direction in two octal numbers (dd) for six bit binary data, e.g. dd = 32 = 1Ah = 26 corresponds to $26 \times 360/64 = 146$ degrees

An example is shown below:

```
<esc>A<stx>A00000AA00000AA00000AA00000AA00000AA00000AA00
000AA00000AA00000AA00000
```

DDP25 part format is the following:

```
<soh><DDP id><stx><space><display control><display
data><etx>
```

For example:

```
<soh>2<stx> CO    0.20<etx>
```

Message Format 4

Message format 4 is for DDP25 digital display data.

```
 <soh><DDP id><stx><space><display control><display
data><etx>
```

For example:

```
>AMES 4
AUTO MESSAGE:      4
>CLOSE
LINE CLOSED
2 CO  0.202 C_  24.182 CO   0.202 C_  24.182 CO  0.202
```

NOTE	The polling command is responded with a special format message, if no automatic message formats have been defined (AMES -1).

Commands

AON and AOFF Commands

Analog excitation pins can be used as controlled outputs. The AON command turns on the excitation power of the parameter channel, and the AOFF command turns it off. This is useful in driving relays.

Several controls can be given as a negative channel number. Then the QLI50 interprets the ten lowest bits of the 16-bit integer values as the setting of all the sensor powers. This parameter handling is the same for the AON and AOFF commands. The AOFF -1 command will turn on all sensor powers.

The command format is the following:

AON *channel number 0 ... 9*
AOFF *channel number 0 ... 9*

An example is shown below:

```
>AON 1        excitation in channel 1 ON
>AOFF 1       excitation in channel 1 OFF
>
```

BAUD Command

The BAUD command without parameter shows the rate that is set after restart (saved to EEPROM).

The default baud rate 1200, can be changed to 300, 1200, 2400, 4800, 9600, 19200, or 38400.

The rate shown can be different from the one you are using now, if you have forced the baud rate to 1200 with the startup trick (see section Powering Up the QLI50 on page 27). This is helpful in fast RS-485 systems when you want to make the setup with RS-232 communication that is not capable of speeds higher than 4800 baud.

The command format is the following:

BAUD *baud rate*

Example:

```
>BAUD
BAUD RATE  1200
>BAUD 333
WRONG BAUD
>
```

CAL Command

The analog input amplifier gains are calibrated using the CAL command.

The calibration sequence is the following:

1. Connect the calibrated voltage to channel 0 differential input.
2. Give command **CAL** *gain calibration_voltage*

Figure 22 Connecting the Calibrated Voltage (5-3)

It is recommended that no measurement sequences are in automatic operation during the calibration.

The command format is the following:

CAL *gain calibration_voltage*

The response is the following:

```
CAL COMMAND
AUTO CALIBRATION
binary data
binary data
until ESC is pressed
SCALE
ii.dddddddd (*1000)
>
```

The QLI50 performs the following tasks:

- Makes the auto-zero calibration.
- Measures the input voltage from channel 0 using the selected gain.
- Displays the binary value 256 time until ESC is pressed.
- If ESC is not pressed during the 256 sample time, the calibration is ignored. The display can be stopped pressing any other character that ESC.

If ESC was pressed, the QLI50 performs the following tasks:

- Detects the polarity of the input signal.

- Calculates the corresponding positive or negative voltage scaling factor from the AD-conversion result and the *Calibration voltage* parameter.
- Saves the new scale to EEPROM.
- Prints the calculated scale × 1000.

Examples of the above are presented below:

```
>CAL 0 -2 >CAL 3 0.022
CAL COMMAND CAL COMMAND

AUTO CALIBRATION        AUTO CALIBRATION
 7FF1 7FF0
 76B6 EFC7
 76B7 EFC8
 76B6 EFC8
 76B6 EFC8
 76B6 EFC9
 76B7 EFC8
 76B7 EFC7
 76B6 EFC8
 76B7 EFC6
 76B6 EFC7
SCALE EFC7
 0.84076000 EFC7
                        SCALE
                        0.00076815
```

CALDAT Command

The CALDAT command is for updating the calibration date text on the EEPROM.

For example:

```
>CALDAT
CALIBRATION DATE:
>CALDAT 940118
CALIBRATION DATE: 940118
>
```

CHAIN Command

The chain mode is used in automatic message modes 3 and 4 to create simple automatic systems.

WAT/DDP Mode (3)

The QLI50 ID must be A, B, C, or D. The required parameters are shown in Table 29 below.

The QLI50 with the CHAIN ON is the master of the system and polls the other (if not a single QLI50 system).

Table 29 Applying the CHAIN Command

QLIs in the system	ID	CHAIN ON	CHAIN OFF
1	A		*
2	A	*	
	B		*
3	A	*	
	B	*	
	C		*
4	A	*	
	B	*	
	C	*	

DDP Mode (4)

The QLI50 IDs must be set to consecutive (binary) values, for example, 1, 2, 3, or C, D, E.

The sequence ID must be 1 in all QLI50 because of the automatic polling.

In all but the last the CHAIN mode is set on, but only in the first QLI50 the automatic measurement parameter *REP* must be set to a proper time. (No *REP* rates must be given for the others.) Proper time is such that the other QLI50s have enough time to send their messages before the next measurement is ready in the first QLI50.

The QLI50 that has CHAIN ON, REP set, and AMES 4, performs the following tasks:

1. Starts the next QLI50 measurement sequence by `<syn><next ID>1<cr>`
2. First sends its own message.
3. Polls the next QLI50 measurement sequence by `<enq><next ID>1<cr>`
4. Waits for next automatic measurement (REP).

The QLI50 that has CHAIN ON and AMES 4, performs the following tasks:

1. Waits for poll.
2. Starts the next QLI50 measurement sequence by `<syn><next ID>1<cr>`
3. First sends its own message.

4. Polls the next QLI50 measurement sequence by
`<enq><next ID>1<cr>`

The QLI50 that has CHAIN OFF and AMES 4 (the last in chain), performs the following tasks:

1. Waits for poll.
2. Sends first its own message.

CLOSE Command

The serial line is released for automatic messages or polling commands with the CLOSE-command.

The command format is the following:

```
CLOSE
Response:
LINE CLOSED
```

CLR Command

Digital counters (0DN ... 7DN) and N1 and N2 can be cleared using the CLR command.

For example:

```
>CLR 1 2 8 9
>
```

The above clears counters 1DN, 2DN, N1 (8), and N2 (9).

DCAL Command

The analog output scaling is calibrated using the DCAL command. The command routine sets two known binary values to the digital to analog converter and calculates the scaling factors for current to binary conversion in the IG command, which is used by the host.

Figure 23 DCAL Command; Connecting of the Reference Meter (5-4)

The scaling factors are automatically stored in the EEPROM.

The ommand format is the following:

DCAL

The response is the following:

```
DCAL COMMAND
GIVE DAC CURRENT give the current in mA from the
reference meter
GIVE SECOND DAC CURRENT lower test current

DAC SCALE 1   scaling factor
DAC SCALE 0   scaling factor

>
>DCAL
DCAL COMMAND
GIVE DAC CURRENT 22.2

GIVE SECOND DAC CURRENT 2.2

DAC SCALE 1   46.180
DAC SCALE 0   -0.955

>
```

DEVREV Command

The DEVREV command is for updating the device revision text on the EEPROM.

For example:

```
>DEVREV
DEVICE REVISION:

>DEVREV D
DEVICE REVISION: D
>
```

DOUT Command

Digital output is set by the DOUT command. The *Data* parameter is logically ANDed with the *Mask* parameter and the result is combined with the old data in the output latch. If the *Mask* parameter is left away, the previous mask is used. (The data is not shifted to LSB (least significant bit) as in the input MSK option case.) If the old mask is zero (default), then the current data is used as mask, that is, only ones (1 bits) have effect.

The command format is the following:

DOUT *data mask*

where *Data* and *Mask* must be integers 0 ... 255. The 1 bits in the mask value define the output bits that are actually updated.

The response is the following:

```
>
```

For example:

```
>DOUT 3 7
>
```

sets digital outputs 0 and 1 to high impedance state and output bit 2 to low.

DTYPE Command

The DTYPE command for updating the device type text in EEPROM.

For example:

```
>DTYPE QLI50A
DEVICE TYPE: QLI50A
>DTYPE
DEVICE TYPE: QLI50A
```

ECHO Command

To prevent echo loop in the two-wire 485 communication, the ECHO OFF command must be given.

HWT Command

When this command is given without any parameter, a small hardware test is executed. Disconnect all the sensors before giving the HWT command.

NOTE	No sensors must be connected to the QLI50.

A more extensive test is done if any parameter is given. The extended test needs a special test jig.

Table 30 Description of the HWT Tests

Test	Typical	Min.	Max.	Description
1	11.9	11		Supply Voltage
2	1.2109	1.0	1.46	Excitation Current mA (IR)
3	25.3	17	34	Internal Pt-100 temperature
4	17.8	17	34	Voltage reference temperature (heat OFF)
5	0.8395	0.6	1.06	Gain 0 scale
6	-0	-90	90	Gain 0 offset
7	-0	-90	90	Gain 1 offset
8	-1	-90	90	Gain 2 offset
9	-9	-90	90	Gain 3 offset
10	-1	-9	9	Gain 0 common mode
11	0	-9	9	Gain 1 common mode
12	0	-9	9	Gain 2 common mode
13	6	-9	9	Gain 3 common mode
14	1			Pull UP/DOWN test
15	1			Digital I/O test
16	4.89	3	5	Ch 9, 5V over 110 ohms, limited
17	4.89	3	5	Ch 8, 5V over 110 ohms, limited
18	12.90	11	14	Ch 7, excitation 12V
19	12.91	11	14	Ch 6
20	12.90	11	14	Ch 5
21	12.90	11	14	Ch 4
22	12.90	11	14	Ch 3
23	12.90	11	14	Ch 2

Tests 1 ... 13 use the standard auto-calibration measurements as input data.

Test 1 shows the approximate value of the power supply. The power supply circuit is tested.

Test 2 checks the constant current source.

Test 3 displays the board temperature, which is expected to be near the room temperature. The Pt-100 element and its connection are tested.

Test 4 displays the voltage reference temperature, when the heating is off. The measurement circuit is a little unstable in this mode, so the value may be several degrees different from the Pt-100 and may vary between tests.

NOTE	When the HWT test is restarted too soon, this test may give FAIL, because the reference is heated at the end of the test and it takes time to cool again.

Test 5 displays the Gain 0 scaling factor, which is calculated by measuring the 2.5 V reference using the Gain 0 and expecting the test voltage to be 2.5000 V. This test is valid only when the QLI50 is not otherwise calibrated (CAL command).

Tests 6 ... 9 display the auto-zero data in bits using all gains.

Tests 10 ... 13 display the common mode effect by measuring the input, when the 2.5 V reference voltage is connected to both of the differential inputs.

Test 14 sets the digital I/O pins to input mode and checks by reading the digital inputs that the pull UP/DOWN control works properly.

Test 15 sets the pull UP mode and writes and reads all bit combinations to the digital I/O.

Tests 16 ... 25 switch the 5/12 V power on and measure the E input.

Test 26 displays the voltage reference temperature after heating since test 14. The heating is switched off after this test.

Test 27 shows the operation of the analog input comparator. It is tested with a 2.5-V difference in the inputs.

Test 28 writes one byte to the EEPROM.

ID Command

The device identifier is set by the ID command. If no parameter is given, the current identifier is shown. The device ID is used in the OPEN-command and in data interrogation by a host computer.

The command format is the following:

ID *id*

where

id = One ASCII number or capital letter.

The response is the following:

```
ID STRING: <id>
Examples:
>ID -
 ID STRING:

removes the identifier
 >ID
 ID STRING: A

 >ID 2
 ID STRING: 2


 >ID
 ID STRING:
 >

 >ID A
 ID STRING: A
```

IG Command

The current output is controlled either by the IGEN block in the measurement sequence or by giving the current in mA as parameter in the IG command.

The command format is the following:

IG *current in mA, 0 ... 20*

The DAC control is set using the DAC scaling factors.

INITEE Command

This command initializes most parameters from the EEPROM. All scaling factors, baud rate, and device ID remain saved whereas Device Type, Revision, Serial number, and Calibration date will be erased.

The command format is the following:

INITEE

The response is the following:

```
ERASE THE EEPROM
ARE YOU SURE?
```

If you do not want the EEPROM to be erased, press N and ↵. To erase the EEPROM, press Y and ↵.

A hardware reset (watchdog) is made after executing the INITEE command and the ECHO is set off.

NEW Command

The current measurement sequences, automatic message number, ON/OFF parameters other than *Echo* and *Repeat* parameters are cleared by this command.

The command format is the following:

NEW

The response is the following:

>

The corresponding location in parameter EEPROM is erased. This command is useful before a new measurement installation.

OPEN Command

The OPEN command is used to assign the serial line for interactive operation. In a multiple device system the unit is selected by different identifiers (ID) set in the configuration. This ID is used to establish the communication link to a certain QLI50 using it as a parameter in the OPEN command.

The OPEN command does not need a parameter, if the device ID is not set and there is only a single QLI50 in the system. The ID is shown at the beginning of the QLI50 restart message (if forgotten).

The *id* can be set as parameter in the ID command. If no identifier is set, the parameter is not checked in the OPEN command.

The OPEN $ command is a master command for any ID. This "master key" can not be used in multidrop systems. OPEN $ will open any QLI50, and the *$* parameter can be used only when there is a single QLI50 connected to the terminal.

The command format is the following:

OPEN *ID*

The response is the following:

```
id OPENED FOR OPERATOR COMMANDS
>
```

An example is shown below:

OPEN *A*

opens the QLI50, whose ID is set to A or none.

The *ID* is seen at the beginning of the comment line and also at the beginning of the reset comment.

```
A OPENED FOR OPERATOR COMMANDS
```

The CLOSE command releases the serial line for automatic output or polling mode.

NOTE	OPEN or any other command is not valid after about 10 seconds from reset, if the automatic message number 3 (WAT/DDP message) is selected. Thus, in such systems the commands can only be given within ten seconds after a power reset. The same applies to continuous automatic messages, if the 2-wire RS-485 communication is used. In this case, the QLI50 pauses the transmission, if `<CR>` is typed while there is a pause between the automatic messages.

PAR Command

The parameter message shows the user defined parameters.

An example is shown below:

```
>PAR
PARAMETERS
VAISALA QLI50 VERSION 0.992 1994-06-01
ID STRING:

VOLTAGE SCALES *1000
G0      0.8364     0.8364
G1      0.0763     0.0763
G2      0.0076     0.0076
G3      0.0008     0.0008
INTERNAL SHUNT   22.0
DAC SCALE 1   40.000
DAC SCALE 0   -0.300
REF HEAT: OFF
```

```
DIGITAL INPUT REF: UP
TEMPERATURE UNIT: CELSIUS
TRIGGER: OFF
CHAIN: OFF
BAUD RATE  1200
ECHO: ON
AUTO MESSAGE:
REPEAT
>
```

PULL Command

The PULL command sets the digital I/O basic state to high or low. The default is up.

The command format is the following:

PULL UP or **PULL DOWN**

An example is shown below:

```
>PULL
DIGITAL INPUT REF: UP

>PULL DOWN
DIGITAL INPUT REF: DOWN
>PULL
DIGITAL INPUT REF: DOWN
>PULL UP
DIGITAL INPUT REF: UP
```

REP Command

When a measurement sequence is defined using the SEQ command, its execution is controlled by the REPeat command. When the measurement timing is done by a host, then the REPeat command is not given or it is given with parameter -1.

The REP command without parameters shows the current settings.

If the time unit is not given, the QLI50 sets it to seconds.

The command format is the following:

REP *sid time time unit*

where

Time unit S	=	Seconds
Time unit M	=	Minutes
Time unit H	=	Hours

An example is shown below:

```
>REP A 1
REPEAT
A   1 S, B, C
>REP B 10 S
REPEAT
A   1 S, B  10 S, C
>REP C 1 M
REPEAT
A   1 S, B  10 S, C   1 M
 >REP B 1 M
REPEAT
A 10 S,  B  1 M,  C  1 H
 >REP C -1
REPEAT
A 10 S,  B  1 M, C
```

NOTE	The repeat parameter is automatically removed, when the corresponding sequence is removed. This may occur also accidentally when the SEQ command is ignored because of a faulty parameter. As a result, both the sequence and the REPeat parameter are removed. The REPeat parameter is saved separately from the sequence. The REPeat parameter is saved to EEPROM at every update, while the sequence is saved only with the SAVE command. If the SAVE command is not given before a reset, the sequence is not restored in the next start and the corresponding REPeat parameter is ignored too. The REPeat parameter, however, becomes only temporarily invisible, that is, when a new sequence with the old name is defined, the old REPeat parameter appears.

An example is shown below:

Define a sequence (id 3) and give the command REP:

```
>SEQ 3 IR RT
*>END
>REP
REPEAT
A   1 S, B   2 S, 3
```

The REP command shows all the defined sequences and the repeat parameters for them. No repeat parameters have been defined for sequence 3. Define repetition rate for sequence 3:

```
>REP 3 3 M
REPEAT
A   1 S, B   2 S, 3   3 M
```

Give the RESET and OPEN command. Sequence 3 has not been saved to EEPROM.

```
>RESET
RESET COMMAND
A VAISALA QLI50
A OPENED FOR OPERATOR COMMANDS
>REP
REPEAT
A   1 S, B   2 S
```

Typing the REP command shows all the sequences that have been saved to EEPROM and their repeat parameters. Define a new sequence with ID 3 and give the REP command:

```
>SEQ 3 TIN IR END
>REP
REPEAT
A   1 S, B   2 S, 3   3 M
```

The REP command shows the old repeat parameters for sequence 3.

RESET Command

The RESET command initiates a hardware restart by the CPU watchdog circuit. It is not exactly the same as in the power-up.

RHEAT Command

The system voltage reference has a stabilized heater that can be connected in use with the RHEAT ON command. By default the heater is disconnected because of its extra power consumption. When heating is selected, the reference chip heats itself to about 75 °C, that is, in most cases the reference is warmer than the environment. Consequently the temperature drifting errors in the reference voltage are eliminated. Especially in a very cold environment, the power consumption may be noticeable (~ +20 %).

The command format is the following:

RHEAT ON/OFF

The response is the following:

>RHEAT
REF HEAT: ON
or
REF HEAT: OFF

An example is shown below:

```
>RHEAT ON
REF HEAT: ON
>
```

SAVE Command

The SAVE command saves the measurement sequences on the EEPROM.

The command format is the following:

SAVE

The response is the following:

```
SEQUENCES TO EEPROM
```

If there is not enough memory for all sequences to be saved, the response is the following:

```
CAN NOT SAVE
```

The minimum amount of memory for each channel is 6 bytes. The total amount of EEPROM space sequences and text is about 900 bytes.

SEQ Command

The measurement sequences are defined using the SEQ-command.

The command format is the following:

SEQ *sid channel configuration* (*options*)...**END**

The command can be stretched on several lines, when the QLI50 asks for more input by the *> prompt until the END block is received.

SEQ sid channel configuration (options)... **>channel configuration (options)...END*

The sequence can also be removed by (shown below)

SEQ *sid END*

The removing may also happen, if all channels are ignored by the input check program.

Examples are shown below:

With a single line command includes all items, see below:

```
>SEQ A TIN UIN END
>
```

With multiple lines and END as the last parameter, see belo:.

```
>SEQ A UIN
*>TIN
*>END
>SEQ B TIN UIN
*>END
>REP
REPEAT
A, B
>SEQ 3 IR RT
*>END
>REP
REPEAT
A, B, 3
>
```

If the channel type is unknown to the QLI50, error message CHANNEL ERROR is shown and the channel is ignored.

```
>SEQ C TR END
CHANNEL ERROR
>SEQ C RT END
>REP
REPEAT
A, B, C
```

If the option is erroneous, error message OPTION ERROR is shown and the option and the channel are ignored.

```
>SEQ C TIN(DLY 2555) END
OPTION ERROR
>
```

As the erroneous configuration was the first in the command, the whole sequence is removed.

```
>REP
REPEAT
A, B

>SEQ C 0V(DLY 25) END

>REP
REPEAT
A, B, C
>
```

SERN Command

The SERN command is used for updating the serial number text in EEPROM. Labels with the original serial number can be found on both sides of the circuit board.

An example is shown below:

```
>SERN A1234567
SERIAL NUMBER: A1234567
>SERN
SERIAL NUMBER: A1234567
>
```

SHUNT Command

The SHUNT command for setting the standard current measurement shunt resistance to other than the initial 22.0 ohms

An example is shown below:

```
>SHUNT
INTERNAL SHUNT   22.0
>
```

STA Command

The status message includes the device identification details and the "dynamic" state of the QLI50.

An example is shown below:

```
>STA
STATUS

VAISALA QLI50 VERSION 0.992 1994-06-01
DEVICE TYPE: QLI50
DEVICE REV: D
SERIAL NUMBER: A1234567
CALIBRATION DATE:
ID STRING:
SUPPLY VOLTAGE   14.3 V
CURRENT  1.2183 mA
IN PT100   30.7
REF TEMPERATURE  28.4
G0 OFFSET     -0.1 COMMON       1
G1 OFFSET     -0.9 COMMON      -0
G2 OFFSET     -4.0 COMMON       1
G3 OFFSET    -37.5 COMMON       2
ROM CHECK 8E3C
>
>
```

TRIG Command

The measurement sequence is executed in the following order:

a. Automatically with the REP intervals.

b. After the polling command.

c. Once trigged by digital input 7 (pin G7) change, if no REPeat interval is set

d. Using the REP interval trigged by the change of the digital input 7 to the selected state, until the input state changes.

The TRIG-command selects the trigger mode and condition. It controls only the first sequence in the REP list. The single-loop mode (edge) is selected by removing the REP time from the first sequence.

The command format is the following:

TRIG ON/OFF 1/0

where

1 = High going edge or high level
0 = Low going edge or low level

The response is the following:

```
TRIGGER: OFF
```

or

```
TRIGGER: ON <0 or 1>
```

An example is shown below:

```
>TRIG
TRIGGER: OFF
>TRIG ON 1
TRIGGER: ON 1
>TRIG ON 0
TRIGGER: ON 0
>TRIG OFF
TRIGGER: OFF
```

Automatic measurement (sequence A) enable, when D7=1

```
>TRIG ON 1
TRIGGER: ON 1
>REP A 10 S
REPEAT
A 10 S, B,  C
>
```

Single measurement (sequence A) trig, when D7 goes 1

```
>TRIG ON 1
TRIGGER: ON 1
>REP A
REPEAT
A
B
C
>
```

TUNIT Command

The temperature unit is selected from Celsius and Fahrenheit using the TUNIT command.

An example is shown below:

```
>TUNIT
TEMPERATURE UNIT: CELSIUS
>TUNIT F
TEMPERATURE UNIT: FAHRENHEIT
>TUNIT
TEMPERATURE UNIT: FAHRENHEIT
>DMES A
    0.02,   78.32
    0.02,   78.38
    0.02,   78.41
```

```
>TUNIT C
TEMPERATURE UNIT: CELSIUS
>DMES A
    0.02,   25.73
    0.02,   25.78
    0.02,   25.78
```

Hardware Description

Figure 24 Simplified Block Diagram (5-5

Connector Block

The connector block can be divided into 4 main sections:

a. Analog sensors interface section.

b. Digital sensors interface section.

c. Communication interface section.

d. Power supply section.

Pin by Pin Connector Descriptions

The pins 1 - 20 (channels 0, 2, 4, 6, and 8) and the pins 35 - 54 (channels 1, 3, 5, 7, and 9) in section 1 are identical.

1 CH0E (35 CH1E)

This input/output pin has five functions depending on the software command for the measurement channel 0. The possible alternatives are the following:

a. Single-ended voltage input, referred either to pin 4 or to pin 21 (AGND) depending on the channel 0 command word.

b. 12 V excitation voltage output for channel 0 sensor powering purposes. The level of this pin may be verified.

NOTE	The excitation voltage may be left continuously on for some purposes assuming the overall current flow from all the CHxE pins and from the +18 V pin does not exceed the level of 100 mA.

c. 15 V excitation voltage output for channel 0 sensor powering purposes. The level of this pin may be verified.

d. 1.2 mA constant current output for bridges and Pt-100 type of sensors. The current excitation can be on during the channel measurement period only and for one channel at a time.

e. GUARD output can be configured to this pin during channel 0 measurement. The GUARD output is a low-impedance mean of the channel inputs CHxH and CHxL being referred to AGND. It is typically used to feed the inner shield of a double-shielded cable in extremely noisy environment. Sensors are typically thermocouples or similar, giving very low output levels. The outer shield of the mentioned cable must be connected to the unit enclosure is done as normally. GUARD signal is active only during the channel measurement period.

2 CH0H (36 CH1H)

This input pin has three functions:

a. Single-ended voltage input, referred either to pin 4 or to pin 21 (AGND) depending on channel 0 command word.

b. Differential HI input conductor for differential measurements. Referred to CH0L.

c. Low frequency input ranging from 50 Hz to 5000 Hz. Note that the signal is monitored and sampled only during the measurement event and is not as accurate as the digital frequency input channels. The trigger point is set to 2.5 V.

3 CH0L (37 CH1L)

This input pin has two functions:

a. Single-ended voltage input, referred either to pin 4 or to pin 21 (AGND) depending on channel 0 command word.

b. Differential LO input conductor for differential measurements. Referred to CH0H.

A 100-kΩ terminator resistor may be activated during channel 0 measurement between the AGND and this input pin to prevent the differential signal from drifting outside the differential common mode range. Always use this option if the differential source has no defined and well-known common return with the AGND (pin 21).

4 CH0C (38 CH1C)

This input has been connected to the AGND level via a 22-Ω resistor. The pin has two functions:

a. Common return and reference level for voltage measurements via pins CH0E, CH0H, and CH0L.

b. Current input for 4 to 20 mA loops or any type of current input up to 100 mA DC. Note that the excitation must be referred to the AGND. To do this, use pin CH0E to power the current loop, or alternatively the +18 V source (pin 55). If external power supplies are used to feed the current loop-type sensors, the power supply must be referred to the AGND pin (pin 21).

CAUTION	Do not apply voltage levels that might cause current flows exceeding 100 mA into this low impedance input. Permanent damage will occur to the QLI50 board if not obeyed. Read specifications.

5 CH2E (39 CH3E)

This input/output pin has five functions depending on the software command for measurement channel 2. The possible alternatives are the following:

a. Single-ended voltage input, referred either to pin 8 or to pin 21 (AGND) depending on channel 2 command word.

b. 12 V excitation voltage output for channel 2 sensor powering purposes. The level of this pin may be verified.

NOTE	The excitation voltage may be left continuously on for some purposes assuming the overall current flow from all the CHxE pins and from the +18 V pin does not exceed the level of 100 mA.

c. 15 V excitation voltage output for channel 2 sensor powering purposes. The level of this pin may be verified.

d. 1.2 mA constant current output for bridges and Pt-100 type of sensors. The current excitation can be on during the channel measurement period only and for one channel at a time.

e. GUARD output can be configured to this pin during channel 2 measurement. The GUARD output is a low-impedance mean of the channel inputs CHxH and CHxL being referred to AGND. It is typically used to feed the inner shield of a double-shielded cable in extremely noisy environment. Sensors are typically thermocouples or similar, giving very low output levels. The outer shield of the mentioned cable must be connected to the unit enclosure as normally. GUARD signal is active only during the channel measurement period.

6 CH2H (40 CH3H)

This input pin has three functions:

a. Single-ended voltage input, referred either to pin 8 or to pin 21 (AGND) depending on channel 2 command word.

b. Differential HI input conductor for differential measurements. Referred to CH2L.

c. Low frequency input ranging from 50 Hz to 5000 Hz. Note that the signal is monitored and sampled only during the measurement event and is not as accurate as the digital frequency input channels. The trigger point is set to 2.5 V.

7 CH2L (41 CH3L)

This input pin has two functions:

a. Single-ended voltage input, referred either to pin 8 or to pin 21 (AGND) depending on channel 2 command word.

b. Differential LO input conductor for differential measurements. Referred to CH2H.

A 100-kΩ terminator resistor may be activated during channel 2 measurement between the AGND and this input pin to prevent the differential signal from drifting outside the differential common mode range. Always use this option if the differential source has no defined and well-known common return with the AGND (pin 21).

8 CH2C (42 CH3C)

This input has been connected to the AGND level via a 22-Ω resistor. The pin has two functions:

a. Common return and reference level for voltage measurements via pins CH2E, CH2H, and CH2L.

b. Current input for 4 to 20 mA loops or any type of current input up to 100 mA DC. Note that the excitation must be referred to the AGND. To do this, use pin CH2E to power the current loop, or alternatively the +18-V source (pin

55). If external power supplies are used to feed the current loop-type sensors, the power supply must be referred to the AGND pin (pin 21).

CAUTION	Do not apply voltage levels that might cause current flows exceeding 100 mA into this low impedance input. Permanent damage will occur to the QLI50 board if not obeyed. Read the specifications.

9 CH4E (43 CH5E)

This input/output pin has five functions depending on the software command for measurement channel 4. The possible alternatives are the following:

a. Single-ended voltage input, referred either to pin 12 or to pin 21 (AGND) depending on the channel 4 command word.

b. 12 V excitation voltage output for channel 4 sensor powering purposes. The level of this pin may be verified.

NOTE	The excitation voltage may be left continuously on for some purposes assuming the overall current flow from all the CHxE pins and from the +18-V pin does not exceed the level of 100 mA.

c. 15 V excitation voltage output for channel 4 sensor powering purposes. The level of this pin may be verified.

d. 1.2 mA constant current output for bridges and Pt-100 -type sensors. The current excitation can be on during the channel measurement period only and for one channel at a time.

e. The GUARD output can be configured to this pin during channel 4 measurement. The GUARD output is a low-impedance mean of the channel inputs CHxH and CHxL being referred to AGND. It is typically used to feed the inner shield of a double-shielded cable in extremely noisy environment. Sensors are typically thermocouples or similar, giving very low output levels. The outer shield of the mentioned cable must be connected to the unit enclosure as normally. The GUARD signal is active only during the channel measurement period.

10 CH4H (44 CH5H)

This input pin has three functions:

a. Single-ended voltage input, referred either to pin 12 or to pin 21 (AGND) depending on channel 4 command word.

b. Differential HI input conductor for differential measurements. Referred to CH4L.

c. Low frequency input ranging from 50 Hz to 5000 Hz. Note that the signal is monitored and sampled only during the measurement event and is not as accurate as the digital frequency input channels. The trigger point is set to 2.5 V.

11 CH4L (45 CH5L)

This input pin has two functions:

a. Single-ended voltage input, referred either to pin 12 or to pin 21 (AGND) depending on channel 4 command word.

b. Differential LO input conductor for differential measurements. Referred to CH4H.

A 100-kΩ terminator resistor may be activated during the channel 4 measurement between the AGND and this input pin to prevent the differential signal from drifting outside the differential common mode range. Use this option always if the differential source has no defined and well-known common return with the AGND (pin 21).

12 CH4C (46 CH5C)

This input has been connected to AGND level via a 22-Ω resistor. The pin has two functions:

a. Common return and reference level for voltage measurements via pins CH4E, CH4H and CH4L.

b. Current input for 4 to 20 mA loops or any type of current input up to 100 mA DC. Note that the excitation must be referred to the AGND. To do this, use pin CH0E to power the current loop, or alternatively the +18 V source (pin 55). If external power supplies are used to feed the current loop-type sensors, the power supply must be referred to the AGND pin (pin 21).

CAUTION	Do not apply voltage levels that might cause current flows exceeding 100 mA into this low impedance input. Permanent damage will occur to the QLI50 board if not obeyed. Read specifications

13 CH6E (47 CH7E)

This input/output pin has five functions depending on software command for the measurement channel 6. Possible alternatives are:

a. Single-ended voltage input, referred either to pin 16 or to pin 21 (AGND) depending on channel 6 command word.

b. 12 V excitation voltage output for channel 6 sensor powering purposes.The level of this pin may be verified.

NOTE	The excitation voltage may be left continuously on for some purposes assuming the overall current flow from all the CHxE pins and from the +18 V pin does not exceed the level of 100 mA.

c. 15 V excitation voltage output for channel 6 sensor powering purposes. The level of this pin may be verified.

d. 1.2 mA constant current output for bridges and pt-100 - type sensors. The current excitation can be on during the channel measurement period only and for one channel at a time.

e. GUARD output can be configured to this pin during the channel 6 measurement. The GUARD output is a low-impedance mean of the channel inputs CHxH and CHxL being referred to AGND, and is typically used to feed the inner shield of a double-shielded cable in extremely noisy environment. Sensors are typically thermocouples or similar, giving very low output levels. The outer shield of the mentioned cable must be connected to the unit enclosure as normally. GUARD signal is active only during the channel measurement period.

14 CH6H (48 CH7H)

This input pin has three functions:

a. Single-ended voltage input, referred either to pin 16 or to pin 21 (AGND) depending on channel 6 command word.

b. Differential HI input conductor for differential measurements. Referred to CH6L.

c. Low frequency input ranging from 50 Hz to 5000 Hz. Note that the signal is monitored and sampled only during the measurement event and is not as accurate as the digital frequency input channels. The trigger point is set to 2.5 V.

15 CH6L (49 CH7L)

This input pin has two functions:

a. Single-ended voltage input, referred either to pin 16 or to pin 21 (AGND) depending on the channel 6 command word.

b. Differential LO input conductor for differential measurements. Referred to CH6H.

A 100-kΩ terminator resistor may be activated during the channel 6 measurement between the AGND and this input pin to prevent the differential signal from drifting outside the differential common mode range. Always use this option if the differential source has no defined and well-known common return with the AGND (pin 21).

16 CH6C (50 CH7C)

This input has been connected to AGND level via a 22-Ω resistor. The pin has two functions:

a. The common return and reference level for voltage measurements via pins CH6E, CH6H, and CH6L.

b. The current input for 4 to 20 mA loops or any type of current input up to 100 mA DC. Note that the excitation must be referred to the AGND. To do this, use pin CH6E to power the current loop, or alternatively the +18-V source (pin 55). If external power supplies are used to feed the current loop-type sensors, the power supply must be referred to the AGND pin (pin 21).

CAUTION	Do not apply voltage levels that might cause current flows exceeding 100 mA into this low impedance input. Permanent damage will occur to the QLI50 board if not obeyed. Read specifications.

17 CH8E (51 CH9E)

This input/output pin has five functions depending on the software command for measurement channel 8. The possible alternatives are the following:

a. Single-ended voltage input, referred either to pin 20 or to pin 21 (AGND) depending on the channel 8 command word.

b. 5 V excitation voltage or...

c. 30 mA constant current output for channel 8 sensor powering purposes. The level of this pin may be verified.

NOTE	The excitation voltage may be left continuously on for some purposes. This pin is a relatively constant voltage output pin up to certain current level. This pin may be short-circuited or used to feed low impedance devices in constant current mode. The current mode is entered if the pin voltage level is forced to be less than 4 V when referred to AGND. The current generator is relatively stable over short periods of time (~100 ms), but drifts depending on time and temperature. The excitation current is measurable when terminated to pin 20. An additional conversion is required for pin 20 in order to do the current measurement.

d. 1.2 mA constant current output for bridges and Pt-100 -type sensors. The current excitation can be on during the channel measurement period only and for one channel at a time.

e. The GUARD output can be configured to this pin during channel 8 measurement. The GUARD output is a low-impedance mean of the channel inputs CHxH and CHxL being referred to AGND. It is typically used to feed the inner shield of a double-shielded cable in extremely noisy environment. Sensors are typically thermocouples or similar, giving very low output levels. The outer shield of the mentioned cable must be connected to the unit enclosure as normally. The GUARD signal is active only during the channel measurement period.

18 CH8H (52 CH9H)

This input pin has three functions:

a. Single-ended voltage input, referred either to pin 20 or to pin 21 (AGND) depending on the command word for channel 8.

b. A differential HI input conductor for differential measurements. Referred to CH8L.

c. Low frequency input ranging from 50 Hz to 5000 Hz. Note that the signal is monitored and sampled only during the measurement event and is not as accurate as the digital frequency input channels. The trigger point is set to 2.5 V.

19 CH8L (53 CH9L)

This input pin has two functions:

a. Single-ended voltage input, referred either to pin 20 or to pin 21 (AGND) depending on the command word for channel 8.

b. A differential LO input conductor for differential measurements. Referred to CH8H.

A 100-kΩ terminator resistor may be activated during the channel 8 measurement between the AGND and this input pin to prevent the differential signal from drifting outside the differential common mode range. Always use this option if the differential source has no defined and well-known common return with the AGND (pin 21).

20 CH8C (54 CH9C)

This input has been connected to the AGND level via a 22-Ω resistor. The pin has two functions:

a. Common return and reference level for voltage measurements via pins CH8E, CH8H, and CH8L.

b. The current input for 4 to 20 mA loops or any type of current input up to 100 mA DC. Note that the excitation must be referred to the AGND. To do this, use pin CH8E to power the current loop, or alternatively the +18-V source (pin 55). If external power supplies are used to feed the current loop-type sensors, the power supply must be referred to the AGND pin (pin 21).

CAUTION	Do not apply voltage levels that might cause current flows exceeding 100 mA into this low impedance input. Permanent damage will occur to the QLI50 board if not obeyed. Read specifications.

21 AGND

This is the internal common return point for all analog input signals. All single-ended voltage measurements are normally referred to the CHxC pin unless the GND option is used as a part of the channel command.

NOTE	Pins 20 (AGND), 30 (GND), 59 (GND), and 62 (GND) are connected to each other.

22 G7

This input/output pin may have four alternative functions.

a. Digital input bit 7 (MSB) of an eight-bit port that consists of pins G0 to G7 (pins 29 to 22) and the reference GND (pin 30). A digital mask is provided in the software to isolate just one required pin (bit) for some purpose that differs from the use of the remaining bits in the port.

b. A digital output bit to control some external devices. In the output mode, the pin has active LO mechanism that can sink relatively high currents and voltage levels. See section Specifications on page 123. A weak pull-up resistor is provided, and it can be programmed to hold the pin in HI state. Use the software commands PULL UP and PULL DOWN to toggle between the two states.

NOTE	Pull-up or pull-down is set simultaneously to the same setting in all the port pins.

c. Low-speed pulse counter input pin with software adjustable debounce times. The debounce settings can be different for the other pins of this digital I/O port.

d. Byte (8 bits) input or output port in conjunction with pins 30 to 22. Binary or six-, seven-, and eight-bit GRAY code types are directly supported by the QLI50 software. Other input types must be solved by the host computer.

23 G6

Digital input/output bit 6. Otherwise identical with pin 22.

24 G5

Digital input/output bit 5. Otherwise identical with pin 22.

25 G4

Digital input/output bit 4. Otherwise identical with pin 22.

26 G3

Digital input/output bit 3. Otherwise identical with pin 22.

27 G2

Digital input/output bit 2. Otherwise identical with pin 22.

28 G1

Digital input/output bit 1. Otherwise identical with pin 22.

29 G0

Digital input/output bit 0. Otherwise identical with pin 22.

30 GND

Common return pin for pins 22 to 29.

NOTE	Pins 20 (AGND), 30 (GND), 59 (GND), and 62 (GND) are connected to each other.

31

This pin is for RS-485 communications with the host computer. The pin has three alternative modes depending on the installed communications module type. Positive half of the RS-485 link.

This communication channel is galvanically isolated from other circuits in the unit. Thus, RS-485 communication is potential-free and does not necessarily need a common return path. However, such a path can be arranged via the unit case by closing the jumper on the communication module. There are also other methods as listed below (refer to pin 63 and pin 64 definitions).

a. RS 485 SD+ (Send Data positive) conductor when RS-232C + RS485 SEND module is used.

b. RS-485 RSD+ (Receive & Send Data positive) conductor when 2-WIRE RS-485 + RS232C SEND module is used.

c. RS-485 RD+ (Receive & Send Data positive) conductor when 4-WIRE RS-485 + RS232C SEND module is used.

32

This pin is for RS-485 communications with the host computer. Negative half of the RS-485 communication link.

a. RS 485 SD**-** (Send Data positive) conductor when RS-232C + RS485 SEND module is used.

b. RS-485 RSD**-** (Receive & Send Data positive) conductor when 2-WIRE RS-485 + RS232C SEND module is used.

c. RS-485 RD**-** (Receive & Send Data positive) conductor when 4-WIRE RS-485 + RS232C SEND module is used.

33 DC+I

This is the positive power supply input for the QLI50 unit. Referred to pin 34. Power supply input is floating from all other circuits in the unit.

NOTE	There is a 1 A silicon diode from this pin to pin 67, the DC+O. This diode causes 0.5 to 1 V voltage loss between the QLI50 units in chain connection. Refer to specification.

34 DC-I

Negative power supply input for the QLI50 unit. Referred to pin 33. This pin has also a direct connection with pin 68, the DC**-**O.

Pins 1-20 and pins 35-54 in analog sensors interface section are identical.

55 +18V

+18V voltage output for various applications. This output is constantly alive, and cannot be shut off. It can be used, for example, to power 2 to 20 mA loop transmitters in conditions, where the 12 or 15 V source does not guarantee fail-safe operation of the transducer in all conditions. It is also designed to source the QLI50's internal current generator output.

This output may not be short-circuited. Failing to obey this rule, causes the QLI50 unit to reset or function improperly. However, permanent damage to the QLI50 unit does not happen.

This output feeds internally the 12/15 V power supply, thus a 100 mA-total limit must be obeyed in order to stay within the specifications in all conditions.

This supply may vary depending on the output load and ambient temperature. Refer to specifications.

+18 V output is referred to pins 21, 30, 59 and 62.

56 IOUT

This is thecurrent generator output pin. This sink-type generator pin receives its excitation voltage typically from pin 55 via the external load or indicator.

57 F1

Frequency or counter input channel up to 10 kHz. This input pin has two operating modes:

a. 0.1 Hz to 10 kHz frequency measurements. Zero crossing trigger option can be selected for sensors of sine wave type.

b. Pulse counter input channel.

58 F2

Frequency or counter input channel up to 10 kHz. This input pin has two operating modes:

a. 0.1 Hz to 10 kHz frequency measurements. Zero crossing trigger option can be selected for sensors of sine wave type.

b. Pulse counter input channel.

59 GND

Reference for **F1** and **F2**. If the sine wave input mode is selected on either channel, it is necessary to use pin 59 as the reference input for the **F1** and **F2** in order to keep the measurement free from unwanted noise spikes.

60 RXD

Serial RS-232C communication input to the QLI50. This signal is usable only if the communication module is of type RS232C + RS485 SEND. Note that the maximum receive baud rate via pin 60 is limited to 4800 bits per second. 9600 bps may work at room temperatures, but there is no guarantee. This RS-port is referred to the digital GND level of the QLI50.

61 TXD

Serial RS-232C communication output from the QLI50. This signal is active regardless of the communications module type and always reflects the outgoing messages.. This pin is usable for monitoring purposes in a RS-485 based systems. This RS-port is referred to the digital GND level of the QLI50.

NOTE	The maximum transmit baud rate via pin 61 is not limited to any certain value

62 GND

Digital GND reference for the RS-232C communications.

63 SRD+

This input/output pin has two modes depending on the attached communications module.

a. RS-485 reference level if 4-WIRE RS485 + RS232C SEND module is used. This conductor may be used to tie the separated receive and transmission paths within the standard RS485 common mode range. In other words, both the inputs and the output in a 4-wire, full duplex system must stay within +12 V and -7 V in respect to the level at pin 63 and pin 64. Simultaneously, if the jumper is installed onto the communications module, the QLI50 case is connected to be the reference to the RS485 communications and the pins 63 and 64 are actually connected to the unit case.

b. Bi-directional Receive and Send positive conductor of the RS-485 communications link when communications module type 2-WIRE RS485 + RS232 SEND is in use.

c. RS485 positive output signal if communication module RS232C + RS485 SEND is used.

64 SRD-

This input/output pin has two modes depending the attached communications module.

a. RS-485 reference level if 4-WIRE RS485 + RS232C SEND module is used. Same as pin 63 definitions in this mode.

b. Bi-directional Receive and Send negative conductor of the RS-485 communications link when communications module type 2-WIRE RS485 + RS232 SEND is in use.

c. RS485 negative output signal if communication module RS232C + RS485 SEND is used.

65

This pin is for RS-485 communications with the host computer. The pin has three alternative modes depending on the installed communications module type. Positive half of the RS-485 link.

This communication channel is galvanically isolated from other circuits in the unit. Thus, RS-485 communication is potential-free and does not necessarily need a common return path. However, such a path can be arranged via the unit case by closing the jumper on the communication module. There are also other methods as found below (refer to pin 63 and pin 64 definitions).

a. RS 485 SD+ (Send Data positive) conductor when RS-232C + RS485 SEND module is used.

b. RS-485 RSD+ (Receive & Send Data positive) conductor when 2-WIRE RS-485 + RS232C SEND module is used.

c. RS-485 SD+ (Receive & Send Data positive) conductor when 4-WIRE RS-485 + RS232C SEND module is used.

66

This pin is for RS-485 communications with the host computer. Negative half of the RS-485 communication link.

a. RS 485 SD**-** (Send Data positive) conductor when RS-232C + RS485 SEND module is used.

b. RS-485 RSD**-** (Receive & Send Data positive) conductor when 2-WIRE RS-485 + RS232C SEND module is used.

c. RS-485 SD**-** (Receive & Send Data positive) conductor when 4-WIRE RS-485 + RS232C SEND module is used.

67 DC+O

Positive DC power supply feed-through for other units in the chain if multiple units are used in the system.

NOTE	Power input for the unit is typically done via pin 33. In applications where the available power supply level is low (down to 10 V), pin 67 may be used to feed the QLI50 in order to save one diode drop (0.5 V to 1.0). In applications, where a simple battery backup is required, a 12-V or 24-V battery positive conductor may directly be connected to this pin while the battery negative conductor is connected to pin 68. This method is also preferable if the battery voltage gets as low as 10.5 V at the QLI50 startup. Feeding the battery power via pins 67 and 68 also reduces the total power consumption since the internal diode causes no voltage losses.

Figure 25 Connecting the Battery Backup (5-6)

A battery charger type of power supply, which has internal current limiting that does not exceed one ampere, may be used to charge the above mentioned battery application from pin 33. If the AC is removed, the diode between pins 33 and 67 prevents the system battery from discharging via the power supply.

Figure 26 Connecting a Battery Charger Type of Power Supply (5-7)

68 DC-O

Directly connected to pin 34. A feed-through path for power supply in chained systems.

Connector X1 Pin Descriptions

Figure 27 Connector X1 Pin Numbers (5-8)

Table 31 Descriptions of the Connector X1 Pins

Pin	Name	Description	Technical Information
1	AIN+	Analog HI signal as seen by the ADC after MPX's and GAIN control amplifiers. Always referred to AIN- signal, not GND.	Varies from + 5 V to -5 V depending on input voltage and selected channel.
2	AIN-	Analog LO signal. Reference level for AIN+.	As pin 1.
3	GND	Digital GND.	Connected to the AGND.
4	GND	Digital GND.	As pin 3.
5	+5 V	+5 V power source for the internal electronics.	+4.5 V to + 5.5 V. 50 mA may be taken for some external applications.
6	-5 V	-5 V power supply for the internal electronics.	Only 2 mA may be taken for some external applications.
7	15-12	+15 V and/or 12 V power supply for sensor excitation.	Varies from 12 V to 15 V depending on channel powering option command. May be loaded up to 100mA if not used for sensor excitation.
8	+18V	+18 V primary source for internal use and for sensor excitation. +12 and +15 V are made of this source.	Valid value between +16 V (fully loaded) and +21 V (unloaded).
9	RESET#	LO when system is in reset.	Output only. May be used to reset some additional circuits.
10	+5OFF	HI level (+2 V to +5 V) causes the +5 V and the -5 V power supplies to shut off. System consumes minimum amount of power.	May be used to stop the QLI50 board operation. Pin 7 remains at +15 V and the +18 V remains on.
11	SCLK	I^2C-bus serial clock.	No external use with standard software.
12	SFTEN	I^2C-bus serial data signal.	No external use with standard software.
13	IN1	Additional digital input pin.	No use with standard software.
14	IN2	Additional digital input pin.	No use with standard software.
21	TXDFT#	Floating optocouple input for RS-232C output driver.	When pulled LO, causes the RS-232C signal to go HI.
22	RXDFT#	Floating optocoupler output.	Goes LO when HI level is at X2 pin 60 (the RS-232C input).
23		No connections.	
24	SDEN	RS-485 transmit enable signal.	LO when transmitting. Referred to FTGND.
25	SRD-	Direct path to X2 pin 64 only.	A bipolar, 15-V overvoltage limiter (Transzorb) is connected to FTGND.
26	SRD+	Direct path to X2 pin 63 only.	A bipolar, 15-V overvoltage limiter (Transzorb) is connected to FTGND.
27	RD-	Isolated RS-485 inverted input.	Normally LO. Referred to FTGND.
28	RD+	Isolated RS-485 non-inverted input.	Normally HI. Referred to FTGND.
29	RD-I	Direct path to X2 pin 32 only.	
30	RD+I	Direct path to X2 pin 31 only.	
31	SD-	Isolated RS-485 inverted output.	Normally LO. Referred to FTGND.
32	SD+	Isolated RS-485 non-inverted output.	Normally HI. Referred to FTGND.
33	RD-O	Direct path to X2 pin 66 only.	
34	RD+O	Direct path to X2 pin 65 only.	
35		No connections.	
36		Case ground.	
37	+7 VFT	Isolated +7 V power source. Internally used for isolated RS-485 driver powering via an +5 V converter. Referred to pin 38, the FTGND (Floating Ground).	Varies from +5.5 V to +8 V depending on load conditions. Can be used for external applications up to 100 mA.
38	FTGND	Floating Ground.	RS-485 and +7 VFT reference level.
39	+7 VFT	Same as pin 37.	
40	FTGND	Same as pin 38.	

Input/Output Section Details

Figure 28 Frequency Inputs F1, F2 (5-9)

Figure 29 Current Generator Output Stage (5-10)

Figure 30 RS-485 Protection (5-11)

Figure 31 Power Supply Input Section (5-12)

Figure 32 RS-485 Interface (5-13)

Figure 33 Digital I/O (5-14)

Figure 34 Simplified Block Diagram, QLY001 (5-15)

Figure 35 Serial Communication Connections, QLY001 (5-16)

An RS-485 serial channel configuration module must be used, if the baud rate higher than 4800 is required. The 2-wire RS-485 mode enables only half-duplex communication. Set ECHO OFF to make the QLI50 ready for multipoint communication (when several QLI50s can be connected to the same two wires).

2-wire RS-485 + RS-232C Send Module

Figure 36 Simplified Diagram, QLY002 (5-17)

Figure 37 Serail Communication Connections, QLY002 (5-18)

4-wire-485 + RS232C Send Module

Figure 38 Simplified Block Diagram, QLY003 (5-19)

Figure 39 Simplified Block Diagram, QLY003 (5-20)

Serial Transmission Standards

Table 32 Serial Interface Standards

?	RS-232	RS-423	RS-422	RS-485
Mode of operation	Single-ended	Single-ended	Differential	Differential
Max. cable length	15 m (50 ft)	1200 m (4000 ft)	1200 m (4000 ft)	1200 m (4000 ft)
Max. data rate	20 kb/s	100 kb/s	10 Mb/s	10 Mb/s

Each standard utilizes different methods for connection between the Data Terminal Equipment (DTE) and the Data Communication Equipment (DCE). Deciding which standard is best suited for an application depends upon a variety of factors including transmission rate, environment noise, cable type, and equipment grounding. Table 32 above shows a summary of the capabilities of the various data interface standards.The DTE/DCE standards cover the electrical, mechanical and functional interface between or among terminals and communication equipment.

Single-ended Data Transmission

In data processing systems of today there are two basic means of communicating between components. One method is single-ended, which uses only one signal line for data transmission. The other is differential, which uses two signal lines.

RS-232C Single-ended (Unbalanced), Non-terminated line

The RS-232C is widely used in industry. The RS-232C is used for single-ended transmission in point-to-point applications over short distances with low rates of data transmission.

Most commercially available sensors, terminals, and display units support the RS-232C interface. This interface should not be used over distances exceeding 15 m (50 ft).

Figure 40 Example of RS-232C QLI50 (5-21)

RS-423 Unbalanced Data Transmission

The RS-423 interface extends the transmission distance over which single-ended data transmission may be sent. It also enables higher rates of data transmission. The following three figures illustrate the different grounding options, and apply also to the other communication standards.

NOTE	Grounding via the case ground as illustrated in Figure 43 below is recommended for indoor use only.

Figure 41 RS-423 Interface, Grounding at QLI50 (5-22)

Figure 42 RS-423 Interface, Grounding at DTE End (5-23)

Figure 43 RS-423 Interface, Grounding via Case Grounds (5-24

Differential Data Transmission

When transmitting at very high data rates over long distances and through noisy environments, single-ended transmission is often inadequate. In these applications, differential data transmission offers superior performance. The differential transmission nullifies the effects of ground shifts and noise signals which appear as common mode voltages on the transmission line.

RS-422 Balanced Data Transmission

The RS-422 interface provides a number of advantages over RS-232C and RS-423. It utilizes differential data transmission, which provides superior performance when transmitting high data rates over long distances through noisy environments.

A possible application for the RS-422 interface is to provide the connection between the QLI50 and a computer or VDU terminal where the distance between them exceeds 15 m (15 ft). Using the RS-422 interface can eliminate the need for a pair of modems between the QLI50 and terminal unit. A proper grounding option, however, has to be selected. It is recommended to use an isolated interface board at the PC end if the interface is brought indoors from an outstation.

Figure 44 below shows that the RS-485 and RS-422 are identical in wiring and that in this example the grounding (option) takes place at QLI50.

Figure 44 RS-485 and RS-422 (5-25)

RS-485 Multipoint Systems Standard

This standard allows up to 32 drivers and 32 receivers to be connected to a single bus, thus enabling a truly multipoint bus **Error! Bookmark not defined.**to be constructed. In the RS-485, multiple drivers and receivers share the same line in data transmission. Transmission distances and rates of data transmission are similar to those of the RS-422. See Figure 44 on page 111.

Figure 45 below illustrates an RS-485 application using half-duplex data transfer over a single twisted pair.

Figure 45 RS-485 Application (5-26)

The following letters refer to Figure 45 above.

D	=	Driver
R	=	Receiver
T	=	Transceiver

Figure 46 Grounding on the Serial Channel Configuration Modules (5-27)

QLI Communication

The QLI50 can operate in the following modes:

- Interactive mode (OPEN, REP, TRIG)
- Automatic message mode (AMES, REP, TRIG)
- Automatic system mode (AMES, REP, TRIG, CHAIN)
- Polled mode (AMES, REP, TRIG)

The automatic and polled messages 1 and 2 are framed as follows:

```
<soh><ID><SID><stx><command mode message><etx><cr><lf>
```

Message type 0 is sent without framing.

The character parity is even, except during message type 3, when there is no parity because of the WAD21 requirements.

Table 33 ASCII - Hexadecimal Equivalents

ASCII	Description	CTRL +	Hexadecimal
SOH	Start of heading	A	01
STX	Start of text	B	02
ETX	End of text	C	03
ENQ	Enquiry	E	05
ACK	Acknowledge	F	06
LF	Line feed	J	0A
CR	Carriage return	M	0D
SYN	Synchronous idle	V	16

CTRL + A means that you press the CTRL key and letter A on the keyboard simultaneously Is this necessary?

Interactive Mode

The interactive mode is used for system setup and check. The measurement sequence is automatic or trigged and the messages are displayed by commands MES, DMES, or TMES.

Automatic Message Mode

When the automatic message number is set to 0, 1, 2, or 4 a data message is sent after completion of the measurement sequence. The TRIG mode can also control the execution of the measurement sequences.

Data message is sent for every sequence when it is measured.

Automatic message 3 is special for the WAD21/DDP25 system. (See message format 3 description in section Message Format 3 on page 68.)

Polled Mode

The QLI50 message sending and measurement timing (starting the sequences) can be controlled by the host computer. The same command that is used in the interactive mode can also be given in a protocol format. The automatic measurements (REP) have to be stopped.

The protocol format of the commands sent to QLI50 is the following:

```
<soh><ID><stx><standard command string><etx><check
high><check low> <cr><lf>
```

The checksum is XOR of characters <soh> .... <etx> as two hexascii characters. There are two exceptions for convenience:

a. There is a 200-ms time out for the checksum. If the QLI50 does not receive the checksum characters in that time, it accepts the input because it is probably a test by the operator.

b. If the host software is not willing to calculate the checksum, it can always replace it with 00, which is always valid, too.

When the QLI50 accepts the message, it sends the following acknowledge message:

```
<ack><ID><cr>
```

Because all commands are not especially done for active use in this mode, the command routine may send its message before the acknowledge. If the QLI50 does not send the acknowledge message, it has ignored the command.

For data logging there are two special commands:

The measurement sequence (SID) is started by

```
<syn><ID><SID><cr>
```

The device <ID> can be replaced by *, which starts the sequence <SID> in all devices in a multiple QLI50 system.

The QLI50 data message can be polled only when there is no automatic measuring interval used (REP time) but the measurements are initiated with the sync command.

The data message (format AMES 0...2) is polled by

```
<enq><ID><SID><cr>
```

The QLI50 responds with the (framed) data message (no checksum). The message is formatted after the request using the latest data. The time between the sync command and the message request should be long enough for the whole sequence to be executed. Typical time for one analog measurement is 100 ms. Digital channels are much faster in the sequence.

Special Polled Mode

If there is no automatic message defined, the special format is used. The data is sent in framed format with checksum. The data items are in the six hexadecimal-digit IEEE format or in the 1 to 4 hex digit integer format. The integer format is used if the data format has zero decimals. The sequence identifier is not included in the frame.

This format is very efficient both in message formatting and receiving because no floating point calculations are needed, just HEX-to-binary conversions. Also the transmitted accuracy remains always the same, no scaling problems with very big or small values. The ignored least significant mantissa byte only slightly reduces accuracy.

The message format is the following:

```
<SOH><ID><STX>FFFFFF FFFFFF IIII I /EE <ETX>HH<CR>
```

where

FFFFFF	=	Describes a real number data field.
IIII and I	=	Describe integer data fields without leading zeroes (negative values are always four digits).
/EE	=	An error code.
Checksum characters HH	=	They are XOR from <SOH> to <ETX> (included).

The single precision IEEE floating point format 24 bits are as follows:

```
SEEEEEEE EMMMMMMM MMMMMMMM MMMMMMMM
```

where

S	=	The sign 0 for positive and 1 for negative.
EEEEEEEE	=	The eight-bit exponent.
MM...	=	23+1 bit mantissa.

The three first bytes are sent as two hex characters each.

For example, the IEEE real data 41FEE2 means that sign bit is 0 = positive number. Exponent 83H-7EH = 5 => 2^5 = 32. The mantissa is first normalized by substituting EMMMMMMM => 1MMMMMMM. Then calculate FEE2H/10000H = 0.9956359. Last calculate 0.9956359 × 32 = 31.8603, which would have been the standard output with four decimals.

Integer data FFFF = -1 and 1F = 31...

Automatic System Mode

Several QLI50's can be configured to make a fully automatic system. Message number 3 is special for the VAISALA WAD21/DDP25 system.(See section Message Format 3 on page 68). Message number 4 is for the DDP25 display systems.

One of the QLI50s is selected as the master unit and the system rate is set with the REP command to this unit. Other units must be also able to transmit their messages within that time.

The sequence id (SID) must be 1 in all the slave units as only that sequence execution is requested in the chained poll.

The CHAIN ON command directs the QLI50 to poll the next device for the (AMES) selected message (ENQ) and new measurement (SYN).

The TRIG mode can also control the master QLI50.

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CHAPTER 5

MAINTENANCE*

This chapter provides information that is needed in basic maintenance of the product.

Periodic Maintenance

The QLI50 operation can be checked with the HWT command (no sensors are not allowed be connected). For details, see section HWT Command on page 76. If the QLI50 fails this test, contact the supplier of the QLI50.

Provide the following information:

- Date of purchase.
- Original serial number.
- Printouts from the STA, PAR, and HWT command outputs.
- A short description of the unit history and applications.

Calibration has been described in Chapter 5. For details, see section CAL on page 71 and section DCAL on page 74 (commands).

Cleaning*

Testing Proper Operation*

Replacing Consumables

This section describes how to replace consumables.

Parts List for Consumables

Table 34 Spare Parts Available for QLI50

Spare Part	Order Code
QLI50 Circuit board	
Housing	
Plastic cover	
Plug connector 4 (16119)	
Plug connector 5 (16120)	
RS cable QLZ001	
Serail communication selection modules QLY001, QÖY002, QLY003	
Termqli program diskette	

CHAPTER 6
TROUBLESHOOTING*

This chapter describes common problems, their probable causes and remedies, and contact information.

Common Problems*

Table 35 Some Common Problems and their Remedies

Problem	Probable Cause	Remedy
The status LED is not flashing.	1. Power has not been connected. 2. Power has been connected to wrong pins.	1. Turn on the power supply. 2. Connect + to pin 33 and - to pin 34.
The status LED light is twitching.	The QLI50 is performing a measurement sequence.	No action is required.
The QLI50 does not respond.	1. Wrong terminal mode. 2. No RS adapter module attached or wrong module attached. 3. Enter has not been pressed within 5 s of power-up. 4. Wrong baud rate at QLI50.	1. Set mode to 1200 baud, 7 data bits, even parity, 1 stop bit for RS-232C. 2. Replace the module (QLY001 for RS-232C). 3. Turn the poser off and then back on. Press enter withing 5 seconds. 4. Set the QLI50 baud rate to correspond the terminal mode (BAUD command).

QLI50 sends strange character combinations	Wrong baud rate at QLI50.	Set the QLI50 baud rate to correspond to the terminal mode (BAUD command)
Your typing is not visible on the terminal.	ECHO is off.	Type ECHO ON (when the QLI50 has been opened for operator commands).
Cannot open the QLI50 for operator commands.	ID is unknown.	Type OPEN $. Then type ID to check the set ID:
Sensor output is out of range.	1. Wrong sensor connection. 2. Scaling options are missing or defined incorrectly.	1. Check the sensor connections. 2. See Appendix a, Example 1 for instructions.
Automatic messages are not shown.	1. AMES has been selected but the line is still open. 2. No repetition interval is set.	1. Type CLOSE to start the measurements. 2. Start mesurements by defining the repetition interval (REP command).

Error Messages*

Table 36 Error Messages

Error Message	Probable Cause	Remedy

Getting Help

For technical questions or for comments on the manuals, contact the Vaisala technical support:

E-mail helpdesk@vaisala.com

Telephone +358 9 8949 2789

Fax +358 9 8949 2790

Return Instructions

If the product needs repair, please follow the instructions below to speed up the process and avoid extra costs.

1. Read the warranty information.
2. Write a Problem Report with the name and contact information of a technically competent person who can provide further information on the problem.
3. On the Problem Report, please explain:
   - What failed (what worked / did not work)?
   - Where did it fail (location and environment)?
   - When did it fail (date, immediately / after a while / periodically / randomly)?
   - How many failed (only one defect / other same or similar defects / several failures in one unit)?
   - What was connected to the product and to which connectors?
   - Input power source type, voltage and list of other items (lighting, heaters, motors etc.) that were connected to the same power output.
   - What was done when the failure was noticed?
4. Include a detailed return address with your preferred shipping method on the Problem Report.
5. Pack the faulty product using an ESD protection bag of good quality with proper cushioning material in a strong box of adequate size. Please include the Problem Report in the same box.
6. Send the box to:
   Vaisala Oyj
   Contact person / Division
   Vanha Nurmijärventie 21
   FIN-01670 Vantaa
   Finland

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CHAPTER 7
TECHNICAL DATA

This chapter provides the technical data of the the QLI50 Sensor Collector.

Specifications

The QLI50 has been designed to operate according to the following specifications over the whole ambient temperature range. However, it is recommended to keep the ambient stress as low as practical in order to minimize component level stress. Maximum ratings should not be exceeded.

CAUTION	Exceeding maximum ratings will terminate the warranty and may lead to permanent damage or shortened lifetime of the unit.

Table 37 Housing and Dimension Specifications for QLI50 Sensor Collector

Property	Description / Value
Material	AlSi 12
Dimensions (without cable glands)	207 × 138 × 62 mm
Weight (incl. PCB and cable glands)	1 300 g
Finish	Epoxy painted
Cable glands	6 installed, max. 12 pieces
Protection class	IP66, equivalent to NEMA 4X

Figure 47 Installation Box Dimensions

Table 38 Printed Circuit Board (PCB) and the CPU Section Specifications for QLI50

Property	Description / Value
Board (no trimmers or jumpers)	Fully coated 2 mm, 4-layered
EMI and ESD protection	Built-in
Cable connectors	Captive, removable
Components for continuous vibration and high temperature withstand	Special rade
Surface mounted components	Included
Processor	Intel 8-bit 80C51FC
Clock frequency	14.7 MHz
SRAM memory	8 kBytes
EEPROM	Serial 1kByte

Table 39 Digital Inputs/Outputs

Property	Description / Value
8 bit I/O port for digital inputs	GRAU code (6, 7, or 8 bits) or 8 open collector outputs or 8 input bits or low-frequency pulse counters of any combination of programmable debounce times
Programmable debounce times	4 to 500 ms per channel
Programmable pull-up/pull-down	33 kΩ to GND or to 12 V all 8 bits simultaneously
8 bit I/O Port Input Level Specifications	
Input high level	min. 5.5 V, max. 30 V
Input low level	min. -1 V, max. 1.5 V
Input resistance	27 kΩ nominal
8 bit I/O Port Current handling Capability Versus Ambient Temperature	
Max. peak current per pin	0.4 A / 20 ms
^{U}sat@100 mA	1.2 V max. = 0.12 W/pin power dissipation
@300 mA	2.0 V max. = 0.6 W/pin power dissipation
Max. total current at the pins (sum.)	800 mA
Max. total power dissipation	1 W @ 25 °C 0.5 W @ 100 °C

Example:		
Continuous current at one pin	100 mA	= 0.12 W
Two other pins	150 mA each	= 0.43 W
		0.55 W

Thus, the maximum ambient temperature allowed at this load is about 90 °C.

Analog Measurement Channels

- 10 differential or 20 single ended voltage inputs.
- 10 current inputs, 22 Ω internal shunt resistors.
- PT-100 -type, built-in thermocouple reference sensor (external reference may be used as well).
- 16-bit sigma/delta A/D converter with digital filter and gains.
- Optionally heated reference for extreme accuracy.

Table 40 Analog Measurement Channel Spcifications for QLI50

Property	Description / Value
Measurement accuracy, voltages	0.006 % of full ± 2.5 V scale
Other gain settings	0.02 % of full scale
Linearity error, full temp. range	± 0.0007 % typ. of full scale ± 0.0015 % max. of full scale
Drift due to ambient temperature	5 ppm/°C typ. (ref. heat off) 10 ppm/°C max. (ref.heat off) 2 ppm/°C typ. (ref. heat on)

Table 41 SW-selectable Analog Input Gains and Resolution

Range	Resolution
- 2.5 V to + 12.5 V	500 uV
± 2.5 V	80 uV
± 250 mV	8 uV
± 25 mV	0.8 uV

Table 42 ?

Gain Setting	CMR L/- input	CMR H/+ input
- 2.5 V to + 12.5 V	- 2.5 V to + 5.0 V	- 2.5 V to + 12.5 V
± 2.5 V	- 2.5 V to + 5.0 V	- 2.5 V to + 5.0 V
± 250 mV	- 2.5 V to + 5.0 V	- 2.5 V to + 5.0 V
± 25 mV	- 2.5 V to + 5.0 V	- 2.5 V to + 5.0 V

- CMRR, all gain settings, DC	105dB typical
- CMRR, all gain settings, 50/60 Hz	120 dB min.
- Input leakage current, all inputs	1nA typ. at ± 25 °C 200 nA max. full temp. range
- Excitation current generator output	1.2 mA nominal min. 1.0 mA, max. 1.4 mA
- Internal Pt-100 sensor	0.3 °C initial accuracy
- Reference heater on/off stabilization	1 minute
- Initial accuracy of current channles 0.1 % (shunt resistor default)	0.02 % with calibration

Serial Channel(s)

- One serial channel, multiple standards
- RS-232C or RS-485, 7 E 1
- Baud rates (software selectable): 300, 600, 1200, 2400, 4800, 9600, 19200, or 38400 bits/s

RS-232C (TXD, RXD, GND)

Non-isolated connection for maintennance/local use.

Max. RS-232C RXD baud rate: 4800 bits/s 2 full temp. range.

NOTE	9600 input operations over RS-232C possible at room temperature (melko väljä käsite, astemäärä olisi selkeämpi) but not guaranteed.

Max. RS-232C TXD baud rate: 9600 bits/s @ full temp. range.

RS-232C output swing	- 8 V to + 8 V max. at no load - 5 V to + 5 V min. 3 kΩ load
RS-232C input treshold	+ 1.5 V to + 3.5 V

RS-485

Half-duplex, 2-wire or full-duplex, 4-wire (lause!). Galvanically isolated for multi-drop connections. All baud rates are available over the full temperature range.

Table 43 Voltage and Current Output Specifications for QLI50

Property	Value
1 current generator output, 10-bit resolution	0.05 to 20 mA
Accuracy	0.2 % of full scale

Table 44 Power Excitation Outputs

Property	Value
One raw output voltage source	± 18 V, 100 mA max.
One raw output voltage source, variation	± 2 V depending on load
2 sofware connectable voltage outputs	5 V, 30 mA each
8 software connectable voltage outputs and/or 1 multiplexed 1.2 mA[1] current generator	12/15 V, 100 mA total

[1] Other currents (e.g. 120 µA) possible, consult Vaisala sales.

Frequency Measurements with F1 and F2 Inputs

Two high-speed frequency inputs either for sine or sqaure wave. The measuring range is from 0.1 to 10 kHz.

Table 45 High-level Counter/Timer Input Mode

Property	Value
Input high-level	min. 2.5 V, max. 30 V
Input low-level	min. - 30 V, max. 0.8 V
Input hysteresis	min. 0.25 V
Input resistance	10 kΩ nominal
Maximum frequency	10 kHz

Table 46 Low-level Counter/Timer Input (Zero Crossing Mode)

Property	?	Value
Input hysteresis		min. 5 V
Min. AC input level	6 mV RMS 20 mV RMS 50 mV RMS 150 mV RMS	0 to 400 Hz 0 to 1 kHz 0 to 4 kHz 0 to 10 kHz
Max. AC input level		20 V RMS
Max. DC offset		± 10 % of Uin peak-to-peak value
Input resistance		10 kΩ nominal

Power Supply

Galvanically isolated switching power supply accepting input voltage ranging from + to 50 VDC.

Start-up level	min. 10.5 VDC
Shutdown level	max. 7.0 VDC
Abs. max. DC input level	max. 50 VDC
Typical power consuption (without sensor supplies)	0.7 W

Table 47 Environmental Specifications

Property	Value
Operating temperature	- 50 °C to + 100 °C
STorage temperature, continuous	- 50 °C to + 100 °C
Storage temperature, temporary	- 55 °C to + 125 °C
Humidy	0 to 100 % RH
Vibration	IEC-68-2-6Fc, 10 to 1000 Hz, up to 5 G
Shocks	Up tp 100 G half sine, non repeatable
Water tightness	IP66
Salt fog resistance	MIL-STD-810E, Method 509.3

Table 48 Electromagnetic Compatibility (EMC)

Property	Value
Conducted emissions	MIL-STD-461C, CE03
Conducted susceptibility (power leads)	MIL-STD-461C, CS02
Conducted susceptibility (all leads)	IEC-801-4 (4 kV transient bursts)
Radiated emissions	FCC15J, EN 55022, class B
Radiated susceptibility	MIL-STD-461C, RS03
Electrostatic Discharge	IEC-801-2 8kV
Reliability	
Mean time between failures	MIL-HDBK-217F Gb 77800 h Gf 22400 h Ns 12300 h

ESD and continuous overvoltage survivability:

- All input/output pins, human body model ± 8 kV
- Case ± 16 kV

Board Layout

The board layout is shown in Figure 48 below.

Figure 48 QLI50 Circuit Board (1-1)

The following numbers refer to Figure 48 above:

1 = Nose
2 = Back
3 = Knee

Block Diagram

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APPENDIX A

APPLICATION EXAMPLES

Example 1

Figure 49 below represents an example of a real measurement configuration for Vaisala HMP35 (Humidity and Temperature Probe), PTB100A (Analog Barometer), WAA15 (Anemometer), and WAV15 (Wind Vane).

Figure 49 Sensor Conncections, Example 1 (A-1)

Figure 49 above shows WAA15 and WAV15 connected through the crossarm WAC15. Wind speed sensor WAA15 is powered from the channel 7 excitation pin. The NL option is used to ignore the voltage data from messages. The PON option is used as the WAA15 needs almost continuous powering. The wind speed from the WAA15 is connected to F1 (pin 57). The output is formatted to be 0.0 to 75.0 (transducer output is 0 to 750 Hz).

The GRAY channel type uses automatically the channel 6 excitation pin for power and the digital input for the data bits. The default data mask is 3FH, which is suitable for WAV15 wind direction sensor. The PULL DOWN command must be given to enable proper operation of the WAV15.

The configuration file Example1.qli is included on the Termqli V 1.1 Installation diskette.

Table 49 Configuration Files

Configuration file	Explanation
PULL DOWN	Enables proper operation of WAV15.
SEQ A \	Measuring sequence A:
1PT100(X1) \	HMP35. Temperature (degC) saved as parameter X1.
3+VE(PON,X2,S1 100,FRM 51H)\	HMP35. Relative humidity (%) with one decimal; saved as parameter X2.
TDEW \	Dew point (degC); calculated from X1 and X2.
0VE(PON,S1 52,S0 800,DLY 30,UN 13)\	PTB100. Pressure (hPa).
UIN \	Primary power voltage (V).
TIN \	Internal Pt100 (degC).
7EVE(PON,NL) \	WAA15 power supply continuously on, ignore voltage data from messages.
F1(S1 0.1,UN 19,FRM 51H) \	WAA15. Speed (m/s) with one decimal.
GRAY(S1 5.625) \	WAV15. Direction (deg).
END \	Ends sequence A.
SAVE	Saves measurement sequence to EEPROM.

Give the CLOSE command to the QLI50 before loading the file. After successful loading, give the OPEN, REP, and MES commands. For example, type OPEN 1 (when the QLI50 ID is 1) as follows:

```
1 OPENED FOR OPERATOR COMMANDS
>REP A 2 S          (could be defined already within the file)

>MES A
1DPT100   26.25 degC,3DVE   33.2 V,TDEW    8.82 degC
0DVE 1003.78 hPa,UIN    14.1 V,TIN   28.14 degC
F1    0.0 m/s,GRAY       0 deg
```

HMP35 temperature sensor PT100 is connected to channel 1 and the humidity output to channel 3. PT100 option X1 is for dew point calculation, that uses the X1 value as the temperature and X2 as the humidity needed in the calculation. Otherwise, the measurement is a standard, 4-wire PT100 measurement. The humidity output is 0 ... 1 V <=> 0 ... 100 % of relative humidity and needs a power supply of 10 ... 30 V. This is a typical voltage measurement with the power supply (VE).

Because frequent measurements were asked in this example, the PON option is used to leave power on for the sensor. For a single

measurement, a one-second delay after the powerup would be needed (DLY 100 option). S1 100 scales the voltage to humidity %. FRM 51H sets the output format to one decimal (default is two decimals). UN 9 option would set MES command data unit string to %.
TDEW is a pseudo channel that calculates dew point temperature for temperature (X1) and humidity (X2). No actual measurement is done.

A PTB100 analog output pressure sensor is connected to channel 0. The output is 0 ... 5 V <=> 800 ... 1060 hPa (see Figure 18 on page 59) and the gradient is:

$$S1 = \frac{1060 - 800}{5 - 0} = 52$$

The y-intercept S0 is 800. The PON option is used because the PTB100 needs about five seconds of power on for full accuracy.

Figure 50 Determining the Scaling Factors S0 and S1 (A-2)

UIN is for the logger power supply voltage and TIN for the internal temperature (PT100).

Example 2

Figure 51 Sensor Connections, Example 2 (A-3)

The following sensors are....:

- PTB200 (pressure)
- DTS12G (ground temperature)
- DSU12 (sunshine on/off)
- CM11 (solar irradiance)
- CUV3 (UV irradiance)

NOTE	The PTB200 pressure sensor is supported by QLI50 software versions 0.995 and later

The PTB200 is used in pulse output mode. Each pulse represents 0.1 hPA, for example, 10000 pulses equal 1000.0 hPa. The RST option is needed to reset the counter between measurements. The repetition interval has to be to at least 3 seconds due to the length of the input pulse sequence.

Remember to start the automatic message mode (type CLOSE) before loading the configuration file. The configuration file Example2qli is included on the Termqli V 1.1 Installation diskette.

Table 50 Configuration Files

Configuration file	Explanation
SEQ B \	Measuring sequence B:
N2(RST) \	PTB200. Pressure (pls).
0V(S1 1000,FRM 34H,UN 0) \	CM11. Voltage (no unit) with four decimals.
2V(FRM 34H,UN 0) \	DSU12. Voltage (no unit) with four decimals.
3V(FRM 34H,UN 0) \	CUV3. Voltage (no unit) with four decimals.
4PT100(3W) \	DTS12A, 3-W PT100. Temperature (degC) with one decimal.
5EVE(PON,NL) \	PTB200. +15 VDC continuously on Ignores voltage data.
9EVE(NL) \	Makes trig. pulse for PTB200. Ignores data from messages.
END	Ends measuring sequence B.
REP B 3 S	Interval between measurements.
AMES 2	Automatic message format.
SAVE	Saves measurement sequence to EEPROM.

After a successful load operation, the QLI50 starts sending data automatically. A message is sent always after 3 seconds.

The following is an example of the produced message:

```
1B   10020,  0.0833, 0.0475, 0.0157, 5.1
1B   10020,  0.0815, 0.0320, 0.0159, 5.2
1B   10021,  0.0823, 0.0253, 0.0160, 5.1
```

The message format is the following:

```
<soh>1B<stx>  , , , , , <cr><lf>
```

APPENDIX B

QLI50 TERMINAL PROGRAM

Overview

The Termqli program serves as a communications link between a computer and a QLI50. With Termqli you can, for example, do the following:

- Send commands to the QLI50 in the interactive mode, see the example below:

```
OPEN 1, ECHO ON, HWT
```

- View the QLI50 responses to the commands:

```
1 opened for operator commands
```

- Configure measurement sequences and send them to the QLI50 in the interactive mode:

```
>SEQ A TIN 0V(PON) END
>REP A 2 S
>MES A
```

- View measurement outputs (messages):

```
TIN 24.41 degC, 0V 8.7 V
```

- Write configuration files which can include commands and sequences (see section Editing Configuration Files on page 139).

- Load configuration files to the QLI50 in the automatic message mode (see section Loading Configuration Files142).
- Make changes to configuration files (with the "Termqli" Editor) and load the same configuration to different QLIs without typing the sequences all over again.
- Save the measurement outputs into a log file for further processing.

For details on the interactive and automatic message modes, see section QLI Communication on page 111.

Installation and Startup

QLI50 Maintenance Terminal Termqli is a terminal program that provides special features for the QLI50 control and configuration. It is delivered on one double-sided, high density 3 ½" diskette.

The following hardware is required to run the program:

- IBM PC or compatible
- 640 kB of RAM memory
- At least one serial port
- Hard disk (optional)
- 3½" diskette drive for installing the program
- Mouse (optional)

The program files take approximately 300 kB of disk space.

CAUTION	Do not touch the read/write head window of the diskette. Do not bend the disk. Do not expose the diskette to magnetic fields. Store the diskette in its protective envelope. The storage temperature range is from 10 °C to 51 °C.

Installation Procedure

1. Insert the program diskette into your diskette drive. Change the disk drive in DOS to correspond to the appropriate diskette drive. For example, type A: as follows:

```
C:\>A:
A:\>
```

2. Type the command:

```
INSTALL
```

3. Define the destination disk drive and the name of the directory as the program instructs. If you do not define a directory, all files loaded from the diskette will automatically be installed to the default directory C:\TERMQLI.
4. The program will ask permission to change your Autoexec.bat to set up the environment. If you give permission, the installation program adds the installation directory to your path statement in your Autoexec.bat file.

NOTE	The installation program checks the available disk space and alerts if the space is not sufficient. In this case, you have to delete some files from the destination drive in order to have the required amount of space or change the destination drive.

5. When installing is completed, change the disk drive to correspond to your hard drive. Type C:

```
A:\>C:
C:\>
```

Starting Termqli

To start the program, type:

```
TERMQLI
```

and then press ENTER.

NOTE	Run the Termqli program always in DOS. Running it from the Windows DOS prompt may cause problems in serial communication.

The connecting of the sensors and the powering of the QLI50 have been described in Chapter 3 in section Installation* on page 17. To enable RS-232C communication, connect the QLY001 adapter on the QLI50 Board and connect the serial cable to the COM1 or COM2 port of the computer. On the QLI50, the plug connector goes to pins 60 (RXD), 61 (TXD), and 62 (GND).

Figure 52 Example of QLI and Sensor Installation (B-1)

Operation

After the startup, the program shows a screen with the main menu titles, see Figure 53 below.

Figure 53 The Terminal Screen (B-2)

The main menu contains **Setup** (Parameters), **QLI** (Load, Editor, Reset), **Modem** (not applicable in QLI50), **Utilities** (Log on, Log off), and **Exit**.

While the following pages introduce the main properties of the Termqli, more detailed information can be accessed directly from within the program by pressing **F1** (see section Basic Measurement Channels on page 50).

On the right, the top row is used for displaying **Status Information**. The **Main Menu** is located on the top left. The rest of the lines on the screen are used by the **Terminal** window to display the commands typed by the operator inputs and the characters received (from?by?) the QLI50.

Usually, the program is controlled in the **Terminal** window, that is, all the characters typed in are sent to the serial port (and to the QLI50) and all the characters received from the serial port are displayed in the terminal window.

There are two ways to transfer the control to the main menu:

a. With a mouse: Move the mouse cursor over the desired field and click the left button. A sub-menu will be displayed.

b. Without a mouse: One character of each of the fields in the main is highlighted. Press ALT and the highlighted character simultaneously and you will get to the corresponding sub-menu. For example ALT+L will display the QLI sub-menu.

Use the arrow keys to move within the menu system. Pressing ENTER or clicking the left mouse button on a field makes a selection. Pressing the ESC key or clicking the left mouse button in the **Terminal** window returns you to the **Terminal** window. Selecting the **OK** or

CANCEL fields will return you to the **Terminal** window when a form is visible.

Some of the choices in the sub-menus are also assigned to so called hot keys. The hot key is displayed to the right of the menu choice. Pressing this hot key invokes directly from the terminal window the operation assigned to a menu choice. For example, pressing ALT+P will display the parameter form.

Setting the Communication Parameters

The **Setup** menu is used for configuring the program. The chosen setup is stored a disk and it will be read every time you start the program.

Figure 54 Setup Screen and Parameters for RS-232C Communication (B-3)

The **Parameters** (form) is used for setting up the serial port line parameters and the file mask for File requester.

Baud rate	Valid choices are 300, 1200, 2400, 4800, 9600, and 19200. Note! Remember also to change the baud rate of the QLI50 correspondingly. Note! When the RS-232C connection is used, the maximum baud rate should not exceed 4800 bits/s.
Data bits	7 or 8 bits can be used.
Stop bits	0, 1, or 2
Parity	NONE, EVEN, or ODD
Serial port	This field specifies which serial port of the PC is used. Valid choices are COM1 and COM2.
RS485 2-W	This field must be set to YES only when two-wire RS-485 connection is used.
File and log mask	These field specify which files should be displayed when File requester window is opened. It can be any DOs filename with wildcard patterna and can also include the path.

Editing Configuration Files

The **QLI Editor** window provides a set of text editing commands. It is used in creating and editing the QLI50 configuration files and editing any DOS file not longer than 31000 bytes. The QLI50 configuration files send commands to the QLI50 device using command packets.

1. Start the **Editor** by pressing ALT+E simultaneously or select the **Edit** choice from the **QLI** menu.
2. In the **File Requester** window, specify the file you want to edit. To select a file, enter its name in the **File** field and press ENTER or select the file in the **File List** display and press ENTER. Only the files matching the search pattern in the **File** field are shown in the **File List** display.
3. The drive and directory can be changed by entering a new path in the **Path** field and pressing ENTER. Another method to navigate through the directories is to select directory entries in the **File List** display.

You can also enter a name for a new file. If you want to change an old configuration file and rename it, do the following:

1. Start the **Editor** and enter the new file name.
2. Press CTRL+Insert and select the file to be edited.
3. Then the old configuration is inserted into the editing window. The current file name is visible on top of the editing area.

Figure 55 Termqli Editor (B-4)

A line starting with a comma (,) is a comment and it is skipped when the configuration is loaded to QLI. All other non-blank lines are either QLI commands or special commands used to control the load procedure. All special commands start with an exlamation point (!). Only one QLI command can be on one line but it is possible to have several special commands on a single line. A QLI command can be spread over several lines by ending all but the last of the lines with a backslash (\). For an example, see below:

```
SEQ A TIN \
4V(PON) \
F1\
END
```

Besides defining measurement sequences (SEQ command), you can include some other commands in the configuration files as well.

NOTE	Do not define a new ID for the QLI50 within a configuration file.

The repetition interval of the measurement sequence can be included in the file, as well as any of the AMES commands. It is also advisable to include the SAVE command so that the sequence is saved into the EEPROM. See section Loading Configuration Files on page 142.

Table 51 Special Commands

Command	Description
!d	Dealy 0.5 seconds.
!r	Reset QLI by sending a long break signal.
!m	Send CR character.
!s	Set communication speed to 1200 bps.
!n	Set original communication speed.

The commands `!s!r!d!m` at the start of a configuration file can be used to reset QLI and get it to use 1200 bps communication during the load operation. Commands `!n!r` at the end of the file will restore the original communication speed.

Table 52 Text Editing Commands

Command	Description
ESC	Quit editing.
ALT + M	Mark region by rows.
ALT + C	Mark region by columns.
DEL	Delete the marked area or character under cursor.
INS	Paste the cut buffer into the text.
CTRL + INS	Insert a file into the text.
GrayPlus	Copy the marked region into a buffer.
GrayMinus	Cut the marked region into a buffer.
ALT + S	Search for a string.
ALT + R	Search for a string and replace it.
UP arrow	Moves the cursor up one character.
DOWN arrow	Moves the cursor down one character.
LEFT arrow	Moves the cursor left one character.
RIGHT arrow	Moves the cursor right one character.
PgUp	Moves up one page.
PgDn	Moves down one page.
CTRL + PgUp	Returns to the beginning of the text.
CTRL + PgDn	Returns to the end of the text.
HOME	Moves to the beginning of the current line.
END	Moves to the end of the current line.
TAB	Inserts a tab character.
BACKSPACE	Delete the character to the left of the cursor.

Loading Configuration Files

Figure 56 Load Screen, File Selection Window (B-5)

Figure 57 Load Configuration File to QLI50, Selection and Progress Window (B-6)

The LOAD command is used for sending a configuration file to QLI50.

NOTE	Give the CLOSE command before you start the loading.

1. Start loading by pressing the **PageUp** key or select the LOAD choice from the QLI menu.
2. Enter the device ID for the device you want to configure, press ENTER and specify the configuration file you want to download.
3. The **Progress** cursor changes its form during the download and you will be notified about the result of the download (Load: Ok). Any responses from the QLI will be shown after a successful download.

If the Termqli detects a command that could not be loaded, it displays "Load Error" and the beginning of the interrupted command. Check, for example, that the sequence syntax is correct: sequence definition is extended to the next line with a backslash (\ ) and it is finished with teh END command.

The special commands like `!r!d` make the loading somewhat slower. If, however, loading takes much longer than 30 seconds, there is probably something wrong in the configuration file or you may have forgotten to give the CLOSE command. In case you want to interrupt loading, press ESC, wait for the prompt "User Break - Ok" and then press ENTER.

If an AMES command has been given within the configuration file, the QLI50 starts sending the message after a successful LOAD operation. To return to interactive mode, give the OPEN command.

To display other message types, for example MES, give the OPEN command after loading and then type the message commands, for example, REP A 3 S and MES A.

Other Operations

The reset command (ALT+R + ENTER) sends a break signal long enough to reset the QLI50 and it responds by sending: VAISALA QLI50.

Logging on/off can be selected from the **Utilities** menu or by pressing ALT+U. Give the log file name in order to start logging. The *.log files can be edited with any text editing programs.

Exiting the program is done by pressing ALT+X or selecting the exit option from the **Main** menu. You will be prompted to confirm before you leave the program.

Termqli Help

QLI Maintenance Terminal Help can be accessed by pressing the **F1** key. Termqli Help first shows the available hot keys:

Table 53 Hot Keys

Edit line parameters	ALT + P
Load configuration to QLI	PgUp
Edit files	ALT + E
Reset QLI	ALT + R
DOS Shell	ALT + Z
DOS Command	ALT + Q
Log on/loff	ALT + O
Clear screen	ALT + C
Send a break character	ALt + B
Exit	ALT + X

On the bottom row there are three activity options. When "Index" is selected, an index of all the Termqli functions is shown. To see more information on a topic, choose it with the arrow keys and press ENTER or double-click with the mouse. "Previous Screen" moves you one screen back where possible and "Exit Help" returns you back to the user screen of the program.

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APPENDIX C
CHANNEL TYPES

AF	Frequency measurement from analog input + channel, ref. 2.5V.
AFE	Frequency measurement from analog input + channel, ref. 2.5V, with power.
ASE	Analog channel state with voltage excitation. CF limit for 1.
ASI	Analog channel state with current excitation.
ASW	Analog channel switch read.
BGE	Bridge, voltage excitation, 4W, BR = excitation voltage value.
BGI	Bridge, current excitation, 4W.
DBY	Digital state input byte with mask.
DN	Digital input low speed counter.
DS	Digital state input bit, n = 0 ... 7, termination high.
F1	Frequency 1, 10 kHz max.
F2	Frequency 2, 10 kHz max.
GRAY	Max. 8-bit Gray code, deafult 6 bits (WAV15).
I	Current, external shunt.
IGEN	DAC current measurement and optional output update.
IR	Excitation current, 1.2 mA.

L	Current loop without power, C pin.
LE	Current loop with power, C pin.
N1	Frequency 1 as counter 10 kHz max.
N2	Frequency 2 as counter 10 kHz max.
PT100	Pt100 linearization, resistance, 1.2 mA excitation.
PT100J	Pt100JIS linearization, resistance, 1.2 mA excitation.
RI	Differential voltage over resistor, 1.2 mA excitation.
RPE	Potentiometer (measured with voltage excitation).
RPI	Potentiometer (measured with current).
RT	Temperature of voltage reference.
SCNT	Measurement loop counter for data control.
TDEW	Dew point temperature calculation form X1 temperature and X2.
TEXT	Additional text to data message.
TIN	Thermocouple reference temperature (default), internal Pt100.
TJ	Thermocouple type J.
TK	Thermocouple type K.
TS	Thermocouple type S.
TT	Thermocouple type T.
UIN	Primary power voltage.
V	Voltage.
VE	Voltage with excitation humidity.

APPENDIX D
CHANNEL OPTIONS

4 W	4-wire measurement.
3 W	3-wire measurement.
2 W	2-wire measurement
AS	nnnnn AD-converter speed
BV	Voltage bridge Vex channel identifier.
CF	Channel factor.
CR	New line in message.
DLY	nnnnn dealy in ms.
FRM	ms message format m.n, if not default.
G0	Fixed gain.
G1	Fixed gain.
G2	Fixed gain.
G3	Fixed gain.
GA	Automatic gain.
GND	Measure against analog ground.
GU	Guard to E-pin.
HS	High speed AD-conversion.

LR	Loop resistance in resistance measurements.
LS	Low speed AD-conversion.
MSK	nnn digital I/O mask.
NL	No output.
PON	Leave E-pin power as it is.
RST	Reset counter when read.
S0	Linear scale 0.
S1	Linear scale 1.
SINE	Sine wave frequency input, low level.
T	Terminate differential input.
TR	Temperature reference identifier, when not internal Pt100.
UN	n 0 ... 31.
UT	Do not terminate differential input.
V12	12 V power instead of 15 V standard (5 V channels 8 and 9).
X1	Parameter.
X2	Parameter.
X3	Parameter.
X4	Parameter.
X5	Parameter.
" "	"Text", max. 14 characters.

APPENDIX E
COMMANDS

AMES ***number***	Set automatic message type.
AON ***channel***	Excitation voltage on.
AOFF ***channel***	Excitation voltage off.
BAUd ***rate***	200, 1200, 2400, 4800, 9600, 19200, 38400
CAL GN ***value***	Analog input calibration.
CALDAT ***string***	Calibraton date.
CHAIN ON/OFF	System configuration.
CLOSE	Releases the line for automatic messages.
CLR ***counter number...***	Clear didgital counter(s).
DCAL	DAC output current calibration.
DEVREV ***string***	Device revision.
DMES ***sid***	Display data message type 2 (,).
DOUT ***data mask***	Write output latch.
DTYPE ***string***	Device type.
ECHO ONN/OFF	Disable input character echo in RS485.
HWT	Hardware test without connections.
ID	Set device identifier character (A - Z or 0 - 9).

IG *current in mA*	Write DAC.
INITEE	Erases EEPROM data.
MES *sid*	Dispaly data message type 0.
NEW	Remove measurement sequences.
OPEN	Assigns the line for operator commands.
PAR	Parameter message.
PULL UP/DOWN	Digital I/O pull UP/DOWN.
REP *sid time unit*	Repeats the defined sequence at a dfined interval.
RESET	Restart with watchdog.
RHEAT ON/OFF	Voltage reference heating control.
SAVE	Saves data structures to EEPROM.
SEQ	Measurement sequence update.
SERN *serial number*	Set serial number.
SHUNT *ohms*	Current measurement shunt.
STA	Status message.
TMES *sid*	Display data message type 1 (tab).
TRIG ON/OFF	Measurement sequence control with digital input D7.
TUNIT C/F	Temperature unit selection.

APPENDIX F
LIST OF ABBREVIATIONS

Abbreviation	Term
AC	Alternating current
A/D	Analog to digital
ADC	Analog-to-digital converter
ASCII	Standard alphanumeric character code (American Standard Code for Information Exchange)
bit	Binary digit 0 or 1 used in computers to store information.
bps	Bits per second
CMR	Common Mode Range
CMRR	Common Mode Rejection Ration
CPU	Central Processing Unit
D/AC	Digital to analog converter
DC	Direct current
DCE	Data Communication Equipment
DOS	Disk Operating System
DTE	Data Terminal Equipment

Abbreviation	Term
EEPROM	Electrically Erasable programmable Read-Only Memory
EMC	Electro-magnetic Compatibility
EMI	Eletcro-magnetic Interference
ESD	Electro-Static Discharge
FTGND	Floating Ground
Gb, Gf	Ground benign, ground fixed
GND	Ground
GRAY code	Digital code used in wind direction sensor.
IBM PC	Personal computer of IBM.
ID	Device identifier character (A - Z or 0 - 9) for QLI50.
I/O	Input/Output
LED	Light Emitting Diode
MTBF	Mean time between failures
MPX	Multiplexer
Ns	Naval sheltered
PC	Personal Computer
ppm/°C	Parts per million/degrees Celsius (drift)
Pt-100	Platinum temperature sensor
RD	Received Data (RS-422, RS-485, RS423)
RAM	Random Access Memory
RMS	Root Mean Square
RXD	Received Data (RS-232C)
SD	Send Data (RS-422, RS-485, RS-423)
SID	Measurement sequence identifier (A - Z or 0 - 9) for

Abbreviation	Term
	QLI50
SRAM	Static Random Access Memory
TXD	Transmitted Data (RS-232C)
VDU	Video Display Unit
WMO	World Meteorological Organization

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